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DECENTRALIZED POWER PLANTS.

In the face of the modern tendency toward the centralization of generating capacity, it is significant that the subdivision of power-plant installations is sometimes more economical than the usual practice of locating all prime movers and dynamos in a single operating room. The typical case is generally furnished by a mill operated in part by water and in part by steam turbines. The limiting feature is nearly always the cost of hydraulic work, and while scarcely any two mills present the same problem in electrical service, it is well to note that almost any combination of steam and hydroelectric equipment can be handled efficiently where the mill departments are run by electric motors.

In mills extending over large tracts of ground and frequently including a half dozen or more power canals on their premises, the possibilities of securing a low cost of electrical production through the use of generators scattered about the works are often most attractive. Rarely does it pay to reconstruct the hydraulic arrangement of a long established mill plant covering many acres. With the old mechanical systems of machine driving the inflexibility of the water-power channels and the high cost of the wheel installations renders it difficult to operate the machinery at best advantage except at times when the supply of water is normal. Usually the flow of water through a mill property fluctuates through almost intolerable limits at different seasons of the year, and hence it is a common experience to find a greater or less proportion of the water-wheel capacity shut down or operating at partial load, with the result that production suffers. Speed regulation also tends to fall off.

Now by the use of electricity the mill owner escapes many of the troubles of limited power which beset his competitor who depends only upon driving by water power. By decentralizing a portion of the generating equipment and yet controlling it all from the main switch house or operating gallery of the power station, the mill management puts itself in a position to absorb the maximum power from the water-wheels throughout the establishment, but more than this, it is enabled, in cases where the generator is mounted upon a long shaft from which many looms or other machines are belt-driven, to operate the generator as a motor in times of water scarcity, and thus to maintain the speed and output of the productive machinery in the mill departments.

In order to accomplish the foregoing it is apparent that

the mill must have available a reasonable amount of auxiliary steam plant which can be drawn upon for several days or weeks when the supply of water is below the normal. Thanks to the development of the steam turbine, with its admirable speed regulation and moderate steam demands even at half load or less, the two sections of the plant can generally be run in co-ordination with perfect success. Under normal circumstances the water supply should be sufficient to produce power to the full rating of the generating units located in isolated corners of the mill, the balance of the service being supplied either by steam auxiliaries in the main power house or purchased from some other company. Possibly it may answer to simply call upon the overload capacity of the steam-turbine plant to furnish the deficiency in power as the water supply begins to run short, but in any event the location of the hydraulic turbine and generator equipment at a distance from the main power house can bring but little inconvenience to the mill owner if the generator is arranged for operation say as a synchronous motor on current drawn from the main steam plant. The mill manager must expect to have to pay more for his power when the water supply shrinks. The difficulty is not so much that as the necessity for shutting down a part of his cloth-making or other revenue-earning machinery, and so far as this particular plan of decentralization has been tried, we have yet to hear of a case where it is regarded unfavorably. There may be some slight increase in the amount of interior wiring required to operate a plant made up of scattered units, and the line losses may perhaps mount up to a little more in cases where the current delivered by the generator is transmitted to the main power-station bus before being sent out to the various mill departments. Even this disadvantage, which is only a slight one compared with the gain in not laying off a portion of the employees, may be overcome by installing a switching equipment near the isolated generator, with the necessary meters and circuit-breaking devices.

Such equipment will permit the generator to be run in connection with local motors when the water supply is good, and the reduction in line losses will conserve the use of water in some degree. Modern remote-control switching apparatus will enable the generator to be handled from the main plant just as well as though its power delivery were made to the station busbars.

Still another important advantage of the use of scattered generators in the above manner is the reduction in the investment in motors required to run the plant. If the looms are driven by belting from water-wheel shafts alone, with no generator mounted thereon, the only alternative to a shutdown wholly or in part during low-water periods is a complete installation of motors in the localities adjoining the water-wheel drives. By using electric generating equipment as outlined, the change from water-wheel driving to operation by the generator run as a motor, is accomplished with ease and fair economy.

A DECADE'S DEVELOPMENT IN ELECTRICAL MANUFACTURES.

The United States Census Bureau has made public the data obtained last year in the thirteenth general census respecting the quantities and values of electrical machinery and all other electrical apparatus manufactured in this country during the preceding calendar year, 1909. A summary of these data appears on other pages of this issue. Comparative data are also given for the years 1904 and 1899.

Everyone has known that there has been a great extension of all branches of the electrical industries, including the manufacture of electrical machinery, apparatus and supplies. However, the official data at hand, despite their incompleteness in some respects, give a nearly exact idea of the actual development in the various electrical manufacturing lines. The progress achieved has been extremely gratifying in practically all the electrical manufactures. The industry as a whole shows a gain of 130 per cent in the annual value of its electrical products during the decade, 1899-1909. This is certainly a most wholesome gain, particularly when it is considered that in the latter half of the decade the gain was larger than in the first half, despite the general depression prevailing subsequent to 1907. Such a showing, in the face of unusual difficulties, is a sure indication of the stability of the electrical industry and of the steadily increasing popularity that is bound to be conceded to all electrical applications.

Attention is called in the official report to some of the more striking data. These are all deserving of special comment, but particular mention will be made here of only a few of them. In the line of generators the comparative figures for the last five years of the decade reflect the marked increase in capacity of machines produced. The increase in annual number of machines built in this period was about eleven per cent, but the increase in rating was over forty-one per cent. The corresponding increase in value was about eighteen per cent, showing that the cost per kilowatt is considerably less than it was for the smaller machines in 1904. The great development of substation equipment is shown by the increase of 730 per cent in ten years in the value of motor-generators, rotary converters, boosters, and similar machinery. In the same period the value of transformers increased nearly 200 per cent.

The increase in the value of electric motors of all kinds during the decade was sixty-four per cent. Of the various classes of motors, those for machine driving and general power purposes showed the largest increase, this being 586 per cent in number and 142 per cent in value for the decade.

In the ten years the annual production of storage batteries increased over eighty-seven per cent in value, while primary batteries showed a corresponding increase of 430 per cent in value and of 1,193 per cent in number, due to the prodigious development of the dry-cell business. A slight falling off in arc lamps during the ten years was expected

because of their being largely supplanted by other types. Contrasted with this was the increase of 273 per cent in value of filament incandescent lamps manufactured in the terminal years of the decade. Many other striking facts could readily be pointed out, but, inasmuch as the different branches of the electrical industry are now more alive to their opportunities and are co-operating more effectively than ever, it is evident that the excellent showing made in the past decade is but an auspicious indication of still greater gains in the future.

ELECTRIFICATION IN SWITZERLAND.

For some years an earnest, and at times heated, discussion has been going on in this country as to the relative merits of direct and alternating current in the electrification of railroads. Although the first two railroads entering New York City to electrify adopted different systems, the experience of several years has not led to any unanimity of opinion as to the relative merits of the two. The users of each system seem to regard that system as the better, from the standpoints of both operation and economy. The principal conclusion to be drawn from this state of the matter is, that both systems are practicable and serviceable, that no overwhelming advantage lies with either one, and that there may be conditions which render the one or the other more suitable for any particular case.

In this connection, the report of the commission which has been considering the subject for the Swiss Government, which contemplates the complete electrification of all the railways in that country, will be of considerable interest, and the principal conclusions of this commission will be found upon page 502 of this issue. The commission has been considering the entire subject for seven years, and the present report is the third which has been issued. The previous reports dealt with mechanical and traffic requirements, while the present report recommends the adoption of alternating current at 15,000 volts, single-phase, and an overhead system.

The electric railways at present operating in Switzerland are about equally divided between direct and alternating current, with two using three-phase current. One of the latter, the Burgdorf-Thun railway, was the first to be built in Switzerland; the other, through the Simplon tunnel, was opened in 1906. The overhead system is used without exception in all the present railways.

In choice of both voltage and frequency, the Swiss railways present as great a variety as one could desire, there being not the least uniformity shown. The commission could therefore, not be prejudiced in this regard by present practice. The later roads to adopt direct current have used voltages of 750, 800, 1,000, 1,200 and 1,500, the latter having been adopted by the Bellinzona-Mesocco road, which has been in operation since 1907. This road is about twenty miles long.

The voltage on the single-phase systems varies from 5,000 to 15,000 volts. The longest road of all, the Rhätische, which, with branches, will cover nearly forty miles, now under construction, will operate at 10,000 volts and sixteen and two-thirds cycles. Of the three-phase roads, the Simplon tunnel operates at 3,000 volts, sixteen cycles; the Burgdorf-Thun at 750 volts, forty cycles.

The frequency recommended in the commission's report is not stated, but those already in use range from fifteen to forty cycles per second. One of the longer and newer roads, the Seethalbahn at Lucerne, uses twenty-five cycles, and the general tendency seems to be toward this figure, in favor of which much can be said. This frequency is used exclusively on the single-phase roads of Italy and England, although in France, Germany and Austria a lower frequency has found more favor, even on the newly constructed roads. Thus the Dessau-Bitterfeld road, opened this year, uses fifteen cycles, and the same frequency has been chosen for the longest line in Germany, that between Görlitz and Breslau. The same is true of a long line now building in Austria, known as the Mittenwaldbahn. Of two long lines now under construction in France, one will use sixteen and two-thirds cycles; the other, in the neighborhood of Limoges in Southern France, will use twenty-five cycles.

FLUID PROPULSION.

On other pages of this issue we present Dr. Nikola Tesla's description of a new principle of fluid propulsion, which is the culmination of his labors of a number of years. As all generation of mechanical power involves the use of a fluid as the vehicle of energy, the underlying idea is a broad one and bears on all the branches of mechanics.

Dr. Tesla avails himself of the two fundamental properties of a fluid, adhesion and viscosity, in an effort to produce a highly efficient mechanism. The fluid, whether receiving or imparting energy, is made to pass along the surfaces of a system of rotating disks in free natural spirals—that is, along paths of least resistance. The efficacy of the machines he has constructed on this principle is evidenced by their remarkable performance, small turbines or rotary engines being run at a peripheral speed scarcely more than half of that of reaction turbines, and giving several times the output of the latter. For example, a small steam turbine exhibited at the Edison station in New York, having a rotor only nine and three-quarters inches in diameter and two inches wide, was capable of developing 110 horsepower with free exhaust. This machine had no blades, vanes, valves or sliding contacts of any kind.

On account of the great simplicity of this apparatus, reversibility and extraordinary output, it will undoubtedly find an immense variety of uses, and the commercial world can not fail to be deeply interested in this new development. The electrical industry, in particular, should be greatly benefited by this latest effort of Dr. Tesla.

The Street Railway System of San Francisco.

At the weekly meeting of the Commonwealth Club, San Francisco, Cal., August 19, Charles N. Black, vice president and general manager of the United Railroads of that city, gave an interesting address on the local street-railway service, explaining many of the difficulties the company had to encounter.

The history of the consolidation of the companies, prior to 1902, was briefly traced, being almost identical, Mr. Black said, with that of many other American cities. Referring to the present valuation of the system, he stated that it had been frequently mentioned that the physical properties of the United Railroads could be duplicated for an amount far less than the bonded debt. These men had built up their business and justly considered that if they disposed of it they were entitled to a value based upon the earning power of their properties at the time of sale. It was expected that the consolidation would effect economies, and the natural growth of the business yield larger profits.

Mr. Black said that prior to the consolidation, each individual road received a five-cent fare for every passenger. Today the average fare for each passenger carried by the United Railroads, by reason of extensive use of transfers, amounts to but 3.37 cents, while the haul is far greater and the convenience, rapidity and comfort of travel have been greatly improved. While many economies have been effected, the cost of increased public requirements for improved service has more than offset them, and the surplus earnings of the company, after the fixed charges have been met, are very much less than they were six years ago.

In speaking of the number of passengers carried, he noted that the maximum hauling inbound in the morning occurred between the hours of 7 and 8 a. m., being 34,000. In the afternoon between 5 and 6 o'clock the maximum is 41,000. The total inbound and outbound in the morning is 51,000 and in the afternoon 64,000, showing that about 13,000 more people are handled between 4 and 5 p. m. than in the heaviest hours of the morning.

Mr. Black stated that it was erroneously assumed that the profit of a street-railway company is derived from the strap-hangers. When this statement refers to the strap-hangers during the hours of congestion of travel, it is absolutely false, for it is necessary to operate many additional cars for a limited period, and to get these cars on the street, there is always what is called "idle mileage" going to and from the barn bringing no revenue. It is from the all-day car carrying a reasonable load that the company derives its profit.

Referring to the local car-mileage, he said that in 1902 it amounted to 18,000,000. In 1903 the car-mileage was increased to 19,548,000. For the present year it will amount to 22,000,000, or an average of 60,000 car-miles a day.

In conclusion Mr. Black said that the serious problem which vitally affects every one interested in the growth and prosperity of San Francisco is the question of transportation facilities for the outlying districts. The present city charter provides that no street-railroad franchise shall be granted for a period of more than twenty-five years. Amendment No. 19 gives the city the right to take over the property at any time at a fixed valuation. It also provides for a wage scale at $3 per day, and the failure to comply with any of the provisions may work an immediate forfeiture of the franchise. Under these conditions it is hopeless to attempt to interest any one in new street-railroad projects in the city, and there seems no way of providing for these undeveloped sections.

Hydroelectric Plant in Spain.

The hydroelectric power-transmission plant for the supply of electricity for the district of Burgos, in Spain, from the River Ebro, was opened last March. A company was established in 1906, and at present two turbines, each of 600 horsepower, are being driven by the water of the Ebro River; the feeding conduit has a length of two miles, and crosses the Ebro once. The turbines are of the Francis type with horizontal shafts and spiral casing. They run at 600 revolutions per minute. Three-phase current is generated at 3,300 volts and 50 cycles. Current, at 30,000 volts, is transmitted to Burgos, more than thirty miles distant, where the tension is reduced to 5,000 volts, and at the distributing stations to 120 volts.

Institute of Operating Engineers.

The first annual meeting of the Institute of Operating Engineers was held in New York City on September 1 and 2. The sessions were held in the Engineering Societies' Building, and papers were read as follows: "Temperature Changes and Heat Transmission," by Vernon L. Rupp; "Boiler-Room Analysis of Coal," by J. P. Fleming; "Cooling Towers versus Steam Pumps," by Henry W. Geare; "A Method of Teaching Operating Engineering," by James A. Pratt; "Engine Lubrication," by R. D. Tomlinson; "Reduction of Lubricating Costs in Smelter Power Plants," by George L. Fales; "Removing Emulsified Oil from Condensed Water," by Darrow Sage.

Addresses were also made by F. R. Low, D. B. Heilman, A. C. Dougall, F. H. Sykes and William D. Ennis. A visit was made to the power house of the Interborough Rapid Transit Company.

Convention of Railway Electrical Engineers.

Arrangements for the annual convention of the Association of Railway Electrical Engineers, to be held in Chicago at the Hotel La Salle, November 6 to 10, are being made by the committees of the Association of Railway Electric Supply Manufacturers. The latter association is composed of some sixty companies manufacturing electrical supplies for use on railways. Membership in this association is prerequisite to the reservation of exhibit space at the convention. The Grand Ball Room on the nineteenth floor of the La Salle Hotel has been reserved for manufacturers' exhibits. Twenty-nine booths ranging in size from 70 to 182 square feet are provided. Requests for further information in regard to exhibits should be addressed to W. E. Ballantine, 436 South Dearborn Street, Chicago, Ill.

Free Rides for Poor Children.

President Shonts, of the Interborough Rapid Transit Company, in a letter to Mayor Gaynor, of New York, offers to furnish free transportation to the inmates of orphan asylums and to sick children and their mothers, to the Bronx, so that they may visit the Zoological Gardens and romp on the playgrounds of Van Cortlandt Park.

Kempster B. Miller.

There is probably no man better known in the engineering field of telephony than Kempster B. Miller, of Chicago, who recently has been prominently before the telephone industry by reason of his being retained as expert by the Los Angeles Board of Public Utilities in fixing telephone rates in that city.

Kempster Blanchard Miller was born in Boston, Mass., in 1870. His parents were Joseph Kempster Miller and Eliza Blanchard. Shortly after his birth Mr. Miller's parents moved to North Carolina, where he atttended common school and later upon moving to Washington, D. C., Mr. Miller attended the Central High School of that city. Upon graduating in 1889 he entered Cornell University, and in 1893 graduated with the degree of Bachelor of Science in the course of electrical engineering. While attending Cornell Mr. Miller worked during the summer months in the drafting room of the Thomson-Houston Company at Lynn, Mass., specializing in electric-controller work.

In 1893 Mr. Miller took the examination for assistant examiner in the United States Patent Office and in the fall of the same year was appointed to that position. He had charge of the class covering telephone apparatus for three years and early in 1896 resigned this position to engage in active engineering work. Shortly after Mr. Miller became connected with the Westinghouse Electric & Manufacturing Company in the capacity of mechanic, but only held this position for three months, when he accepted the position of chief electrician with the Western Telephone Construction Company of Chicago. In this position Mr. Miller, in addition to designing all of the apparatus manufactured by the company, acted as superintendent of the factory. In 1898 Mr. Miller resigned to accept a position with the International Correspondence Schools of Scranton, Pa., as a writer of textbooks on telephone and telegraph subjects. These books are still used as references in the telephone and telegraph courses of this institution. In the spring of 1899 Mr. Miller became connected with the Kellogg Switchboard & Supply Company, of Chicago, as engineer, which position he held for nearly six years. He had a large part in developing the present standard apparatus of this company and was one of the minority stockholders that fought the suit for the annulment of the sale of that company to the Bell interests, which suit was finally successfully terminated after going to the Supreme Court of Illinois twice.

In 1904 Mr. Miller resigned from the Kellogg Company and established partnership with Samuel S. McMeen under

KEMPSTER B. MILLER,
Telephone Engineer.

the firm name of McMeen & Miller, for the general practice of consulting engineering, particularly in telephony, telegraphy and signaling.

Mr. Miller's career, since being actively engaged in consulting engineering, has been a notable one. He was retained as expert to investigate the New York City fire-alarm and telegraph system for the New York Board of Fire Underwriters, and later designed the new system which subsequently replaced the old one, the latter work being done for the municipal authorities. More recently Mr. Miller made a study of the telephone situation in Los Angeles, Cal., including an appraisal of the plant of the Pacific Telephone & Telegraph Company, and an investigation of the business of the company for the purpose of determining the rate controversy between the city and the company. On account of Mr. Miller's familiarity with patent matters gained from experience in the patent office, he has kept in the patent field and a considerable portion of his efforts have been in the direction of expert work in connection with patent litigation. He has served in some very important patent cases not only in the field of telephony, telegraphy and signaling, but also in other electrical arts, notably that relating to motor control and electric elevators. In recent years Mr. Miller has broadened his field of activities so that now he devotes considerable attention to power and lighting work, particularly that dealing with valuations of public-utility properties both for municipal and corporate interests.

Mr. Miller has contributed largely to the literature of telephony and telegraphy, his most notable work being "American Telephone Practice," a book which is recognized as an authority on telephony, and which has enjoyed a remarkably large circulation. During the past year, in collaboration with Mr. McMeen, Mr. Miller has written a new work entitled "Telephony," which will soon be published, although a considerable portion of it has already been embodied in an encyclopedia on telephony issued by the International Correspondence Schools.

Mr. Miller is an active member of the American Institute of Electrical Engineers, and the Western Society of Engineers, and has contributed greatly to the discussions and papers of these institutions. He is also a member of the Chicago Electric Club, Union League Club of Chicago, the Quadrangle Club, the Engineers Club of Chicago, and the Engineers Club of New York. He has served as chairman of the Chicago Section of the American Institute of Electrical Engineers, and upon its Telephone Committee.

Why the Government Telegraph System in England Is Not Remunerative.

Sir Herbert Samuel, Postmaster-General of Great Britain, in a recent speech in the House of Commons, explained why the Postoffice telegraph system lost £1,000,000 ($5,000,000) a year. He said:

"It has been said that the Post Office is not to be trusted with the management of this business (telephones) because postoffice inefficiency has been proved by the fact that our telegraphs are worked at a loss which now amounts to about £1,000,000 a year. The loss on the telegraphs is due to four causes.

"In the first place there are the low press rates which are quite unremunerative, and which were granted by Act of Parliament at the time of the transfer of the telegraph business to the State. These very low press rates account for a loss of about £200,000 ($1,000,000) a year, and it is sometimes amusing to read newspaper articles asserting that the inefficiency of the postoffice is proven—when the fact is that under Parliamentary pressure we gave unduly low press rates—and that therefore the telephones ought not to be entrusted to our hands. These same newspapers are at the moment enjoying the unremunerative rates which they would be very unwilling to surrender.

"Secondly, we have deliberately extended the telegraph system in the rural districts for general purposes of national development in a way that a commercial company would not have done. It has been done with the sanction of Parliament and by various Governments with their eyes open, knowing that a loss would accrue, but believing that it was well to spend some part of our postal surplus in incurring that loss rather than leave the rural districts unprovided with telegraphic facilities.

"Thirdly, when the telegraphs were on the point of paying their way, and when the earlier deficits were being made good, the House of Commons stepped in and rejected, a good many years ago, the advice of the Postmaster-General of that day, and insisted on a system of six-penny telegrams which are in very many cases unremunerative, and which account for a considerable portion of the loss. But even six-penny telegrams might have been made to pay in the course of time, if it had not been for the intervention of the fourth consideration, namely, the development of the telephone itself, which has been actively fostered by the postoffice, and the effect of which has been to take away a most remunerative part of their business—the short-distance telegrams between different parts of the same towns.

"Telegraphy has completely altered its character in recent years. The bulk of the telegrams used to be telegrams dispatched short distances, but now the bulk of telegrams are becoming more and more telegrams which are sent over long stretches of the country, and which are not of a remunerative character at the six-penny rate. When the average cost of dealing with a telegram now as compared with twenty years ago is considered, you find that a telegram dealt with now is a different thing from what it was twenty years ago, owing to the advent of telephony. The fact that there has been a loss on the telegraphs is not due to inefficiency, but is owing to the operation of these four reasons.

"While the telegraph system does not pay, I think the House of Commons would prefer that there should be a loss paid out of the postal surplus than that either the press rates should be raised or that the country districts should be without facilities, or that the six-penny rate should be increased, or that the substitution of telephony for telegraphy should be hampered."

Swiss Electrification.

The commission which has been investigating the question of the electrification of the Swiss National Railways will recommend the adoption of the overhead system. This decision has been arrived at after most careful comparison with the third-rail system. It is seven years ago that the State authorities of Switzerland appointed their first commission—then a body of twenty-two expert engineers and electricians—to investigate the whole question of railway electrification. This commission has since issued three reports; the first dealing with the probable power requirements of the whole federal system, consisting of 1,830 miles; the second with the nature of the traffic; and the third with the choice between continuous and alternating current. The new report will recommend the adoption of single-phase alternating-current system, with a pressure of 15,000 volts in the overhead wires. The first work to be taken in hand will be the conversion of the St. Gothard Railway, and comparative estimates have shown that the adoption of the third-rail continuous-current system would involve a capital expenditure of about eight per cent more than with the overhead system. The total cost of conversion to electric traction upon the overhead system is estimated at $13,000,000, while the running costs are estimated at about ten per cent less than the present cost with steam traction.

Electrical Code of New York City.

Commissioner Thompson of the Department of Water Supply, Gas and Electricity, New York City, has just issued rules and regulations for the construction, care, maintenance and operation of all electrical work, apparatus, and appliances in the city. The booklet is entitled, "The Electrical Code of the City of New York."

This is the first time, says the commissioner, that anything of this kind has been attempted by the department. It was undertaken for the particular benefit of the electrical trade and contractors, but it should be of general use to all people who use electricity. It took many months to prepare the work.

Methods of obtaining various kinds of permits from the department are explained; the rules under which the department inspectors work, and the general regulations for the construction and maintenance of all kinds of electrical work. Particular attention is devoted to moving-picture establishments and a series of suggestions for all kinds of interior wiring is included. Copies can be obtained at the office of the department free of charge.

Commonwealth Edison Buys Land.

The Commonwealth Edison Company, of Chicago, has bought from Northwestern University approximately two and two-third acres adjoining the electric company's substation at Quarry Street and the south branch of the Chicago River.

The tract fronts on Quarry Street, the Chicago River, Evans slip and the Chicago & Alton Railroad. The consideration was $81,250. The company already had the property under lease for a period of ninety-five years.

An Irrigation Pumping System.

The Minidoka Hydroelectric Project.

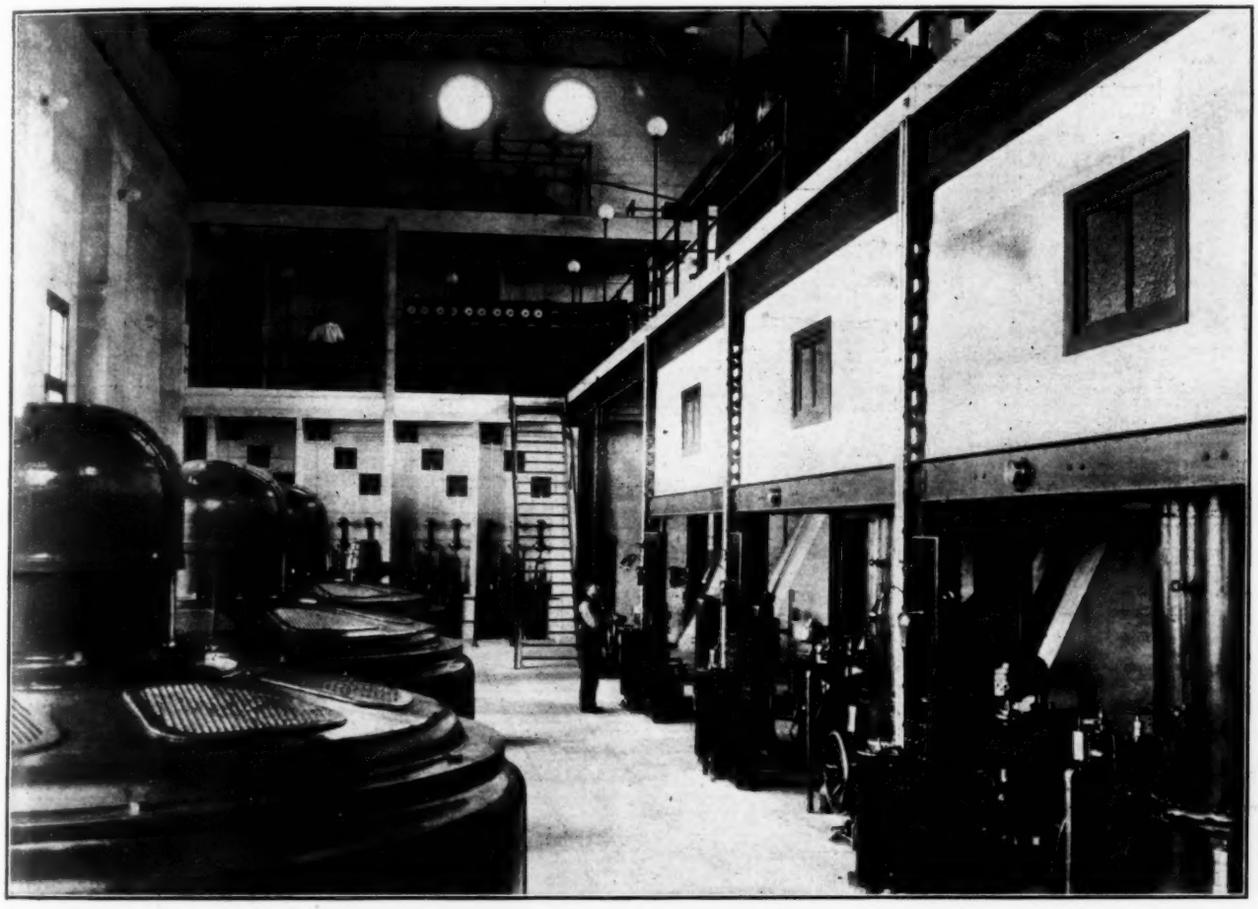
BY JAMES M. GAYLORD.

What is said to be the largest hydroelectric development in the country for purely irrigation purposes is the Minidoka power system in Southern Idaho, built and operated by the United States Reclamation Service.

This system constitutes a part of the Minidoka Project, which includes approximately 120,000 acres of land lying on both sides of the Snake River. Of this total acreage about 70,000 acres are watered by gravity while the remaining 50,000 acres are served by pumps. The dam which diverts from the Snake River the water necessary for these lands backs up the water sufficiently to produce a head of forty-six feet, and the power which has thus become available has been developed and transmitted to pump water from the gravity canals onto the high lands south of the river.

A flow of one second-foot continuously throughout the irrigating season is provided for each 100 acres of land and since the average lift is seventy-three feet, it is readily seen that a considerable amount of power is required to supply water to the 50,000 acres of high land.

The Minidoka Dam was built in 1904-6 and in its design provision was made for a power plant, although the construction of this plant was not begun until 1908.



INTERIOR OF MINIDOKA POWER HOUSE.

POWER PLANT.

The main part of the dam is of the rock-fill type, but a concrete section closes the diversion channel, which was cut through the lava rock at the north side of the river and which served to divert the stream from its natural channel during construction. Against the down-stream side of this concrete dam the power house has been built. The building is of reinforced concrete, 150 feet long, 50 feet wide and rises to a height of 98 feet above the bottom of the tail-race.

The hydraulic equipment consists of five 52.5-inch vertical turbines, each one of which is capable of developing 2,100 horsepower at 200 turns per minute.

The turbine cases are of plate steel and are connected to the ten-foot opening in the dam by steel penstocks. With the limitations imposed by small space available and the size of the penstock openings, this was the largest size of unit which could be installed and in securing 2,100 horsepower at 200 revolutions per minute with forty-six feet gross head, a runner of the most highly developed type was required.

The turbines are placed on the lowest floor of the plant with the center line of the wicket gates seventeen feet above tail water. They are supported by reinforced-concrete arches built up from the tail race and on the floor above are located the alternators to which the turbines are coupled.

The thrust bearing carrying the weight of the rotating parts is at the top of the generator, which puts the entire shaft in tension and places the thrust bearing where it can be easily inspected by the operators. These bearings are of the simplest possible construction, consisting of two collars of cast iron, provided with suitable oil grooves and running in a simple oil bath, no pressure being used. A cooling coil arranged for water circulation is placed in the oil outside the wearing plates. The total load on this bearing is 40,000 pounds and the friction loss shown by test in regular operation is 12.5 horsepower.

Thermometers have been provided for indicating the temperature of the oil and the only attention given these bearings is regular inspection by the operator to see that the water is flowing in the cooling oil and that the temperature rise is not abnormal. During two years' operation the thrust bearings have given absolute satisfaction. Gas-engine-crank-case oil is used and the same oil has been in use in some of the bearings over a year.

Two 180-horsepower exciter turbines driving the 125-volt exciters have been provided and the arrangement of these units corresponds closely to that of the main turbines, except that the thrust bearings are located on the turbine cases. These units operate at 425 revolutions per minute.

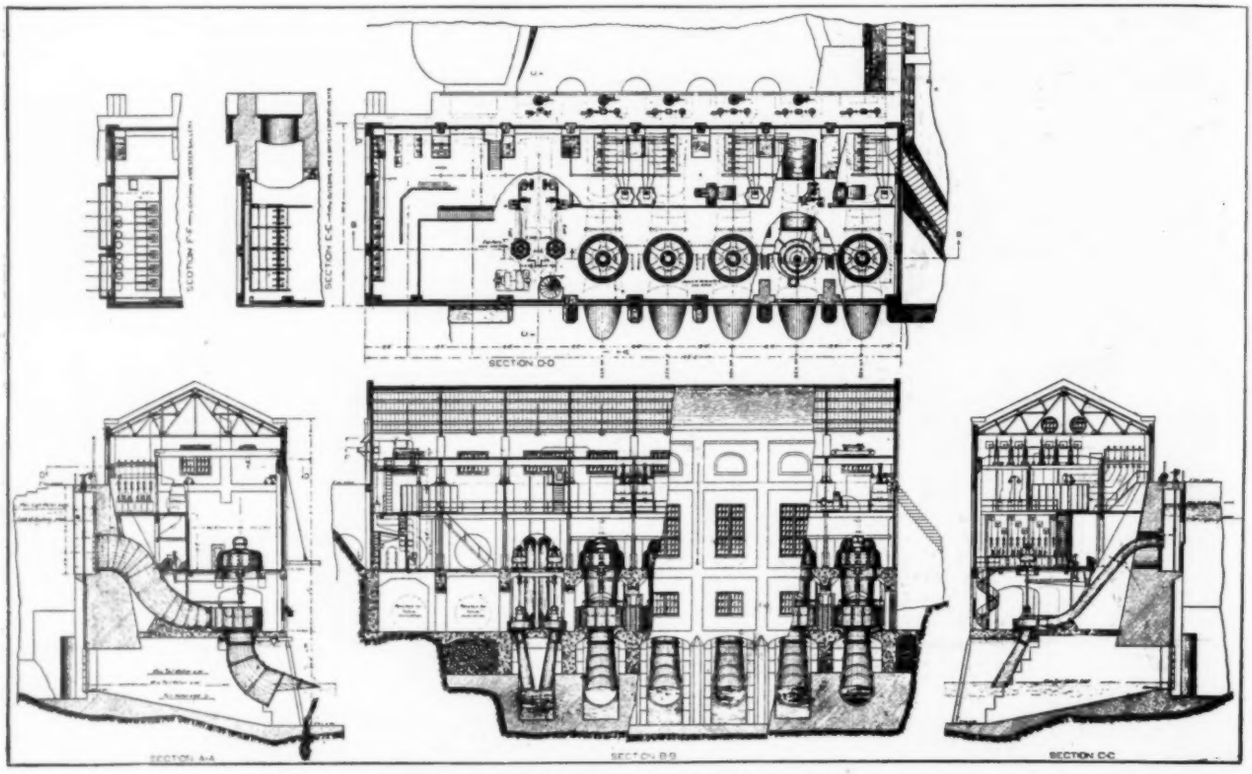
At the head of each ten-foot penstock is a cast-iron sliding gate controlled by means of a direct-current motor from a switchboard panel on the generator floor. This gate is provided with two stems both geared to the same motor. Two auxiliary gates operated directly by the stems have been provided to fill the penstock and equalize the pressure on the gate, so that the only load on the lifting mechanism is the weight of the gate itself amounting to 12,000 pounds.

A suitable limit switch is geared to one gate stem and this, in conjunction with the controller and circuit-breaker gives complete protection to the mechanism, at the same time permitting quick operation. Vertical trash racks at the face of the dam prevent foreign matter from entering the penstock. The exciter penstock gates are similar to the main-turbine gates, but these are hand-operated.

The oil-pressure governors are located on the generator floor under the transformer gallery and are supplied with oil through brass piping from a central oil system.

Oil under 175-pounds-per-square-inch pressure is supplied by motor-driven gear pumps. Unsatisfactory experience with a combined pressure and vacuum system for the governors led to the adoption of the single-pressure system, the oil flowing from the exhaust of the governor cylinders to an open tank, from which it is taken by the gear pumps and returned to the pressure tanks. While in the open tank, the oil has sufficient time to settle and the foam and gas is allowed to escape. This results in longer life of the governor oil and of the governor valves. A good grade of engine oil is used in the governor system and it is found that this can be used for a year or more before it becomes broken down to the extent that renewal is necessary.

The governors have given excellent satisfaction and actual tests have shown that with full load gradually taken off the generator, the speed of the unit varies approximately two per cent. When full load is suddenly thrown off, the



GENERAL ARRANGEMENT OF MINIDOKA PLANT.

governor closes the gates in one and one-half seconds.

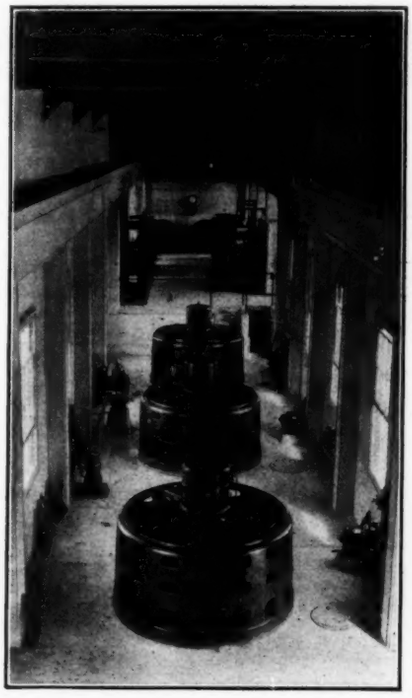
Each generator is connected through disconnecting switches to a three-phase air-blast transformer, which delivers 33,000-volt current to the high-tension busses. These transformers are placed on a gallery which runs the length of the power plant against the downstream face of the dam and extends also across the north end of the building for accommodating the main central board.

This type of transformer fits into the general scheme of the station admirably and has given excellent operating results. A large air duct directly under the transformers receives air from two motor-driven fans, either one of which is of sufficient capacity to cool all of the five transformers. The transformers are delta-connected on the low-tension and Y-connected on the high-tension side with the neutral grounded.

Oil circuit-breakers of 33,000-volt size connect the transformers to the duplicate high-tension busses. These busses are run with copper tubing supported openly on line insulators over the gallery. At the north end of the building the busses enter concrete compartments and pass through to the line switches on the generator floor.

The special gallery above the transformer and switchboard carries the lightning-arrester equipment, consisting of electrolytic cells and horn spark gaps. This has proved an excellent location for this apparatus, for while it is close enough to be under the constant observation of the operators, yet the noise of the discharge it is not annoying.

The main control board is on an extension of the transformer gallery at the north end of the plant and the panels command a full view of the machinery they control. All switching is done at 33,000 volts by means of solenoid-operated switches. The governors are controlled by electric motors and the generator field rheostats are motor driven. Thus the switchboard attendant, while at some distance from the machine, has practically complete control of the entire plant within his reach.



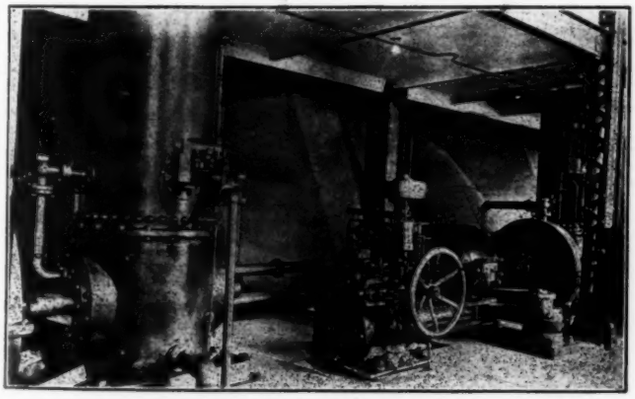
INTERIOR OF PUMPING STATION NO. 1.

The apparatus is connected on the unit system, each generator being provided with its own transformer, to which it is connected by disconnecting switches. All synchronizing of generators is accomplished by means of the 33,000-volt oil switches which connect the transformers to the duplicate high-tension busses.

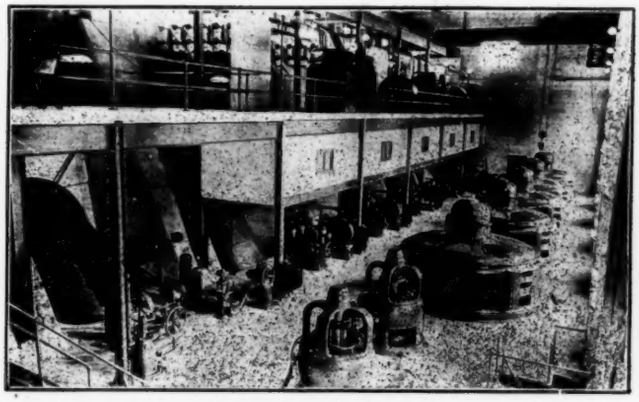
As already stated, the object of this power development is to provide power for pumping water and the main load on the generating plant comes from three pumping stations located at an average distance of eleven miles from the power plant. A single-circuit wooden pole line running straight across country connects the plants, while a second circuit twenty-one miles in length forms a loop with the other line for supplying the pumping stations. A branch from the longer line furnishes power to the various towns of the project. A standard two-piece porcelain insulator is used throughout the lines. The conductors are for the most part three-wire strand, the equivalent of No. 5 B. & S. The spans on all except the oldest lines average 250 feet in length. The lines cross the river at three points and at each of these points steel towers and long spans are used. A switching tower at the point where the branch leading to the towns joins the main line and paralleling switches at the pumping stations make it possible to cut out various sections of the line in cases of necessity.

PUMPING STATIONS.

There are three pumping stations, the lift being approximately thirty feet in each case. Thus part of the water is lifted thirty feet, part sixty and part ninety feet. The acreage under the thirty-foot lift is roughly 10,000 acres; under the sixty-foot lift 15,000; and under the ninety-foot lift 25,000. The first lift has a total capacity of 575 second-feet, the second of 500 and the third a capacity of 325 second-feet. Two sizes of pumps are used, one having a capacity of 125 second-feet, the other a capacity of seventy-five second-feet. The arrangements of the various sta-



TURBINE GOVERNORS.



INTERIOR OF MAIN PLANT. EXCITERS IN FOREGROUND.

tions are so similar that a description of one applies with very little modification to all three.

The first of the pumping stations draws its water from the main south-side gravity canal. Power is taken from either transmission line through disconnecting switches onto the single station bus, which is provided with an oil switch which serves to cut off the entire station when necessary. Three-phase air-blast transformers deliver 2,200-volt current through expulsion fuses and disconnecting switches to the low-tension station busses.

The pump motors and auxiliary apparatus are connected to this bus. All the switches are hand operated, the low-tension switches being controlled directly from the main switchboard while the control panels for the high-tension transformers are placed near their respective switches. Two motor-driven exciters are located near the main switchboard and electrolytic lightning arresters are provided for the protection of the station apparatus.

The pump is of the double-suction, vertical, centrifugal type, designed for a head of thirty-one feet. Each individual pump is in a separate concrete compartment at such an elevation that the top suction inlet is normally submerged three feet. Motor-driven steel sliding gates cut off each pit from the forebay and trash racks prevent the entrance of foreign material.

In order to meet the varying requirements of the irrigating canals, close regulation of the discharge of the pumps is essential and this has been provided for in the design of the pumps. A cylinder gate similar to those used on hydraulic turbines has been inserted just outside the impeller and serves to control the opening from the impeller into the volute. This gate is controlled from the floor of the station by means of a hand wheel and in this way close regulation of the discharge is possible.

The driving motor is located on the floor above the pump and the two shafts are direct-connected by clamp couplings. The weight of the moving parts is carried on a roller thrust bearing at the top of the motor. The motor is a three-phase, synchronous machine, receiving power at 2,200 volts and operating at 300 revolutions per minute. The rotor is provided with an auxiliary squirrel-cage winding and compensators are used to reduce the voltage applied in starting.

INTERIOR PUMPING STATION NO. 2.

A unique method is employed to reduce the load on the motor to a minimum while starting. In putting a unit into operation the pump-pit gates are closed and by opening a special by-pass valve, the pump is allowed to discharge back into the forebay while coming up to speed with the motor running on the compensator. In this way, the pit is emptied in about one minute. The motor then rapidly approaches synchronous speed and the field is excited. There has been very little trouble with this method of starting, the current drawn from the line does not at any time exceed full-load current. The whole operation requires not over two minutes.

The discharge pipes are of reinforced concrete, 5.5 feet in internal diameter. The upper ends of these pipes are provided with steel swinging check valves which prevent the return of the water when a pump is not in operation.

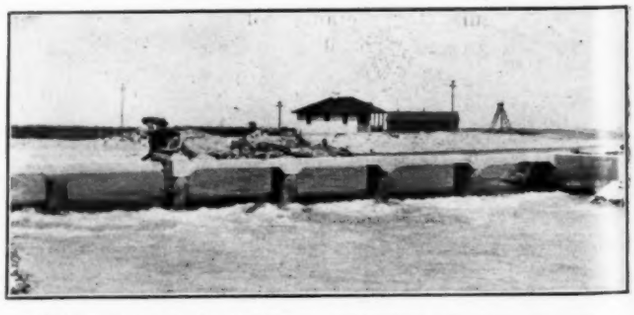
POWER FOR COMMERCIAL USE.

The operation of the power system for irrigation pumping is required only about six months out of the year and this makes the development of a winter load highly desirable in order that at least the foundation of an operating force be held together throughout the year.

This and the desire to promote the welfare of the project has resulted in the extension of the transmission lines to the three project towns where power is delivered to local companies or to the town authorities for local distribution. Power and light are sold at very low rates and energy for heating purposes is sold on a flat rate of $1.00 per kilowatt per month for unlimited use. At this rate, electricity is practically as cheap as coal and is used very extensively in the various towns.

The design and construction of this development was carried out by the Reclamation Service under the immediate direction of O. H. Ensign, chief electrical engineer. The turbines, pumps and transformers were furnished by the Allis-Chalmers Company, while the switchboards, generators and motors were made by the Westinghouse Electric & Manufacturing Company.

EXTERIOR PUMPING STATION NO. 2.



CANAL ABOVE STATION NO. 1, SHOWING PUMPED WATER.

DESIGN OF AUXILIARY POLES.

BY ALBERT BRUNT.

The design of auxiliary poles has been thoroughly discussed in the electrical periodicals during the last couple of years and different methods for calculating the required number of ampere-turns per auxiliary pole have been given. Numerous designers have tried these methods out and in most cases found that, to a larger or smaller extent, they give good results, but have met with other cases where the results were unsatisfactory. Others satisfy themselves by taking, for each auxiliary pole, a number of ampere-turns equal to the armature ampere-turns per pole plus a certain percentage (varying from 5 to 50 per cent) of these armature ampere-turns. This percentage, however, has to be found experimentally and, when found for a certain line of machines, is likely in some case or other to give wrong results. This way of proceeding, therefore, is to be considered as unsatisfactory.

In using the methods published during recent years, one is impressed with the fact that all are to a certain degree incomplete. The way of proceeding is to figure the reactance voltage in the short-circuited coil and from this the field strength required to generate a voltage in that coil equal and opposite to the reactance voltage. In developing a formula for the reactance voltage, the authors assume more or less improbable conditions which give correct results only in so far as the actual conditions agree with the assumed ones.

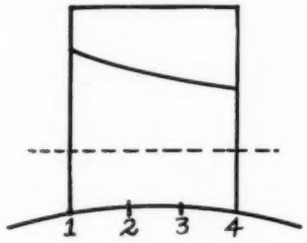


FIG. 1.

The most popular assumptions are a brush width equal to one commutator bar, only two conductors per slot and the upper one beginning the commutation at the same moment as the lower one. It is obvious that a brush width extending over several commutator bars, more than one coil per slot and a difference in phase of commutation between the upper and the lower part of a slot will influence the reactance voltage considerably. The aim of this paper is to take into account all these different conditions and to produce a complete and exact method for calculating the auxiliary poles and winding.

It has been the practice to supply a machine rather liberally with auxiliary ampere-turns and when on test, if the machine appeared to be overcompensated, to shunt the necessary amount of current from the auxiliary circuit, thus complicating the wiring of the machine. In the opinion of the author, a designer must be able to calculate the auxiliary ampere-turns so correctly as to make the above procedure altogether unnecessary. Further, an auxiliary-pole machine should run sparklessly with the brushes in the neutral zone (the brushes are understood to be in the neutral zone when in the case of a motor the same speed is obtained at full load for either direction of rotation) making the brush position independent of the direction of rotation and the load, from no load to fifty per cent overload at speeds varying from the normal to fifty per cent overspeed; this range of speed, of course, has to be much extended in the case of adjustable-speed motors.

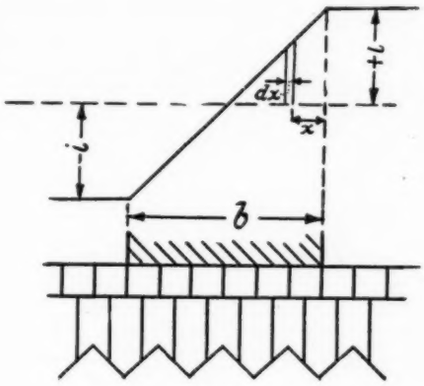


FIG. 2.

It is a well known fact that a machine, when too much undercompensated (*i. e.*, auxiliary field too weak) will spark at the toe of the brush, whereas in case of overcompensation sparking will occur at the heel of the brush. Though indicating, in case of an unsatisfactorily commutating machine, the direction in which changes should be made to secure good commutation, this will not always reveal the real cause of the sparking, for it is obvious that a machine may spark at the heel or toe of the brush for some other reason than over or undercompensation in which case a change in the auxiliary air gap or the ampere-turns probably will not have the desired result. It is, therefore, necessary to have other and better means for testing the correctness of excitation and dimensions of the auxiliary poles.

A very simple test, giving complete information regarding the commutating conditions, is the following: One lead of a low-reading voltmeter, conveniently in the shape of a hard lead-pencil point, whose other lead is connected to the brush holder, is kept in the positions 1, 2, 3 and 4 (Fig. 1) on the commutator and readings are taken in these positions. The obtained readings plotted down against the brush width show a curve (Fig. 1) which will be called brush-potential curve. A set of these curves, taken at different loads and different speeds, will give the required information regarding the commutation. It is obvious that the ordinate of the brush-potential curve at each point represents, on a certain scale, the current density under the brush at that point. The relation between the shape of this curve and the commutating conditions will be shown.

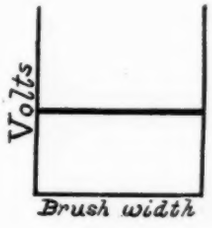


FIG. 3.

The ideal commutation is the so-called straight-line commutation, whereby the intensity of the current in the short-circuited coil is a linear function of the time (Fig. 2) in which case the reactance electromotive force during the whole short-circuit period is constant, making it possible, by moving the short-circuited coil with constant velocity in a magnetic field of constant strength (auxiliary field), to generate, in the short-circuited coil, an electromotive force at every moment of the short-circuit period equal and opposite to the reactance voltage. It can easily be shown that in this case the current density all over the brush has the same value.[1]

1 Arnold, *Die Gleichstrommaschine.*

Let l = total length of all brushes of one brush rod.

b = width of the brushes.

Then (Fig. 2) the current density in a certain point of the brush is.

$$\frac{i\frac{\frac{b}{2}-x}{\frac{b}{2}} - i\frac{\frac{b}{2}-(x+dx)}{\frac{b}{2}}}{l\,dx} = \frac{i\,dx}{l\frac{b}{2}dx} = \frac{2i}{bl} = s_s$$

where s_s is a constant.

The brush-potential curve will be a straight line parallel to the axis of the abscissæ (Fig. 3).

Considering now the more general case of the commutation not being straight-linear, but as shown in Fig. 4, the current in the short-circuited coil can be imagined to consist of two parts: First, the current which should flow through the coil in case of straight-line commutation (i_s) and, second, an additional short-circuit current (i_{ad}) so that

$$i_k = i_s + i_{ad}$$

The current density at a point X will be

$$s_x = s_s + \frac{d\,i_{ad}}{l\,dx}$$

which shows that in the figure, showing

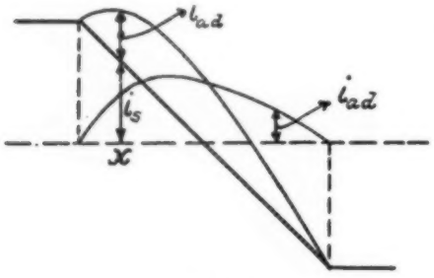


FIG. 4.

the brush current density, if the axis of abscissæ be shifted over a distance s_s in the positive direction we obtain that part of the brush current density which is caused by the additional short-circuit current, plotted on a new axis of abscissæ and because of the additional short-circuit current flowing through the brush and the armature coils, the total surface between this curve and the new axis must be equal to zero. (This is only quite correct for multiple armature windings; for series-wound armatures where coils are short-circuited by brushes of different brush rods of the same polarity, however, it is as nearly corect as is necessary for the following considerations.) The formula for s_x shows that the brush current density plotted on the new axis of abscissæ is the differential curve of the i_{ad}-curve (Fig. 4) or: the i_{ad}-curve is the integral curve of the brush-potential curve on the new axis. This enables us (the brush-potential curve being known) to determine the shape of the i_{ad}-curve as follows.

Find the new X-axis by the consideration that the surface of the vertically shaded part (Fig. 5a) must be equal to that of the horizontally shaded part. An ordinate of the brush-potential curve on the new axis is equal to the tangent of the angle between the tangent of the i_{ad}-curve at the corresponding point, and the X-axis. At the point p where the brush-potential curve crosses the X-axis and where thus:

$$di_{ad}/dx = 0$$

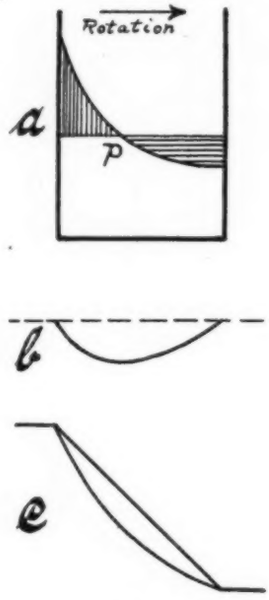


FIG. 5.

the tangent to the i_{ad}-curve must be horizontal; the approximate shape of the i_{ad}-curve is shown in Fig. 5b, and the ordinates of this curve added to the corresponding ones of the straight-line commutation curve, gives the approximate shape of the actual commutation curve (Fig. 5c). This particular curve shows overcompensation, having a too strong interpole field. Fig. 6 is an example of the curves for an undercompensated machine and Fig. 7 of a machine where either the brush width is too large or, what amounts to the same, the auxiliary pole tip is too narrow.

A set of these brush-potential curves taken for different loads will give complete information as to the overload capacities of the machine as far as sparking is concerned. The reactance voltage is practically proportional to the load; the auxiliary flux, however, may not be proportional to the load, depending upon the degree of saturation of the path of the auxiliary flux. Fig. 8 gives an assumed saturation curve of the auxiliary poles. If at full load with an amount of auxiliary ampere-turns equal to *oa*, level compensation is obtained (Fig. 9, $^2/_2$), practically the same effect will be obtained at fifty-per-cent overload, the actual auxiliary flux *oe* being nearly equal to the required flux *of* and a set of curves as shown in Fig. 9 may be the result.

In working with more saturated auxiliary poles, for instance at full load with an amount of auxiliary ampere-turn equal to *oc*, giving a level brush curve (Fig. 10, $^2/_2$) then at fifty-per-cent overload with *od* auxiliary ampere turn, we find the machine to be undercompensated, the required flux being

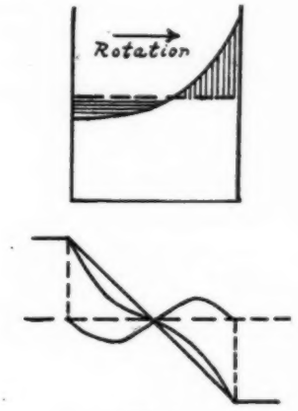


FIG. 6.

equal to *oh*, whereas the actual flux is only *og*. This machine will give a set of brush-potential curves of the shape shown in Fig. 10.

If curves taken on a motor, when running with a weakened main field, show the motor to be strongly overcompensated whereas at normal speed flat brush curves are obtained. then this indicates a too highly saturated frame.

It must be borne in mind, however, that the method for finding the relations between the brush curves and the compensation characteristics is strictly correct only on the assumption that the brush covers a large number of bars. This in fact, is not the case, but need give us no concern as it is not intended to find the absolute value of the commutation curve, but only its

approximate shape in order to enable us to judge of the correctness of the design of the auxiliary poles and winding. It must be understood that the voltage read at a certain point of the brush is not only an average over the time for a rotation of the commutator, amounting to the width of one commutator bar, but is also an average for the different coils of one slot.

The preceding will have shown of how much importance the taking of these brush-potential curves is. With the results of these tests at hand, the intelligent designer will be able to determine how a poorly commutating machine should be changed in order to obtain better results.

In designing the auxiliary poles, the first point to be settled is the width of the interpole tip, to be found by the consideration that the armature coils,

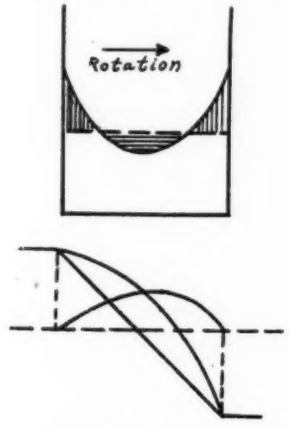


FIG. 7.

during the short-circuit period, must be under the influence of the auxiliary pole. Thus reasoning, the width of the pole shoe must be equal to the width of the commutating zone, when by commutating zone is to be understood that part of the armature where one or more armature coils are in short-circuit. An allowance of the double air gap may be made for the fringing of the lines of force when entering the armature.

The following symbols will be used:

b = brush width, given in commutator bars.

p = number of pole pairs.

a = half the number of parallel armature circuits,

$a = 1$ for two-circuit windings.

$a = p$ for multiple windings.

Z = number of slots.

K = number of commutator bars.

m = number of commutator bars per slot $= K/Z$.

y_1 = front pitch of armature winding, given in halfcoils.

y_2 = back pitch of armature winding, given in halfcoils.

ϕ = difference in phase of commutation between an upper and a corresponding lower conductor of a slot, given in commutator bars.

β = width of one commutator bar, figured at the armature circumference.

$\beta = \pi \times$ *armature diameter* $\div K$.

For series windings:[2]

$$y = y_1 + y_2 = \frac{2Zm \pm 2a}{p} = \frac{2K \pm 2a}{p}$$

Assuming a series-wound armature as shown in Fig. 11, we see that in the position of the brushes as in this figure, coil I is at the moment of beginning the commutation; the width of the commutating zone of this coil is determined by the position of the brushes 1 and 3 relative to those commutator bars that carry the ends of this coil. Should only

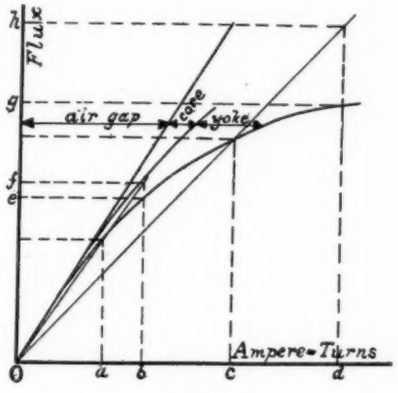


FIG. 8.

brush 1 influence the commutation of coil I, then the width of the commutating zone of this coil would be:

$$(b+1)\,\beta$$

The influence of brush 3 decreases this by an amount equal to the difference between $(K \pm a)/p$ (= the coil pitch on the commutator) and K/p (= twice the brush pitch), thus giving the width of the commutating zone for one coil as:

$$\beta\left[b+1\pm\left(\frac{K}{p}-\frac{K\pm a}{p}\right)\right]=\beta\left(b+1-\frac{a}{p}\right)$$

After the commutator has moved over a distance equal to the width of one commutator bar, the next coil begins commutation, so that the width of the commutating zone for the upper part or the lower part of a slot is:

$$(b+1-a/p+m-1)\ \beta=(b-a/p+m)\,\beta.$$

The difference in phase between the upper and lower part being $\phi \times \beta$ the total width of the commutating zone will be:

$$w_c = (b - a/p + m + \phi)\,\beta.$$

In this formula the numerical values of all the factors can be readily substituted except the one for ϕ, which requires some further explanation. In the position as shown in Fig. 11, coil I, *i.e.*, conductors 1 and $1 + y_1$, are about to begin commutation. When the commutator has moved over a width equal to $a/2p$ commutator bars, the coil X will begin to commutate. Counting the conductors as shown in the first slot of Fig. 11, a certain commutator bar x is connected with conductor $2x - 1$ (bar 2 with conductor $2 \times 2 - 1 = 3$, bar 3 with conductor 5, etc.) and thus is bar $1 + (K + a)/2p$, (in which one lead of coil X ends) connected with conductor $1 + (K + a)/p$ this conductor forming with conductor $1 + (K + a)/p + y_1$ the coil X. This shows that the upper conductor $1 + (K + a)/p$ begins commutation $a/2p$ commutator bars after the lower conductor $1 + y_1$ making the difference in phase ϕ, as used in our formula,

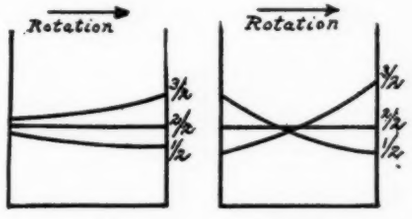


FIG. 9. FIG. 10.

$$\phi=\frac{1+\frac{K+a}{p}+1-(1+y_1)}{2}-\frac{a}{2p}$$

or, as in general the commutator pitch is $y_k = (K \pm a)/p$:

$$\phi=\frac{1+\frac{K\pm a}{p}+1-1-y_1}{2}\mp\frac{a}{2p}=\tfrac{1}{2}\left(1+\frac{K}{p}-y_1\right)$$

This formula for ϕ may be written in a somewhat simpler form.

Let y_s = slot pitch $= (Z \pm a)/2p$ and $y_1 = 2my_s + 1$.

(1) Assume $Z = K/m$ so that:

$$\tfrac{1}{2}\left(1+\frac{K}{p}-y_1\right)=\tfrac{1}{2}\left(1+\frac{Zm}{p}-2m\frac{Z\pm a}{2p}-1\right)$$

$$=\mp\tfrac{1}{2}\frac{ma}{p}=\phi$$

(2) Assume $Z = (K + 1)/m$, then:

$$\tfrac{1}{2}\left(1+\frac{K}{p}-y_1\right)=\tfrac{1}{2}\left(1+\frac{Zm-1}{p}-2m\frac{Z\pm a}{2p}-1\right)$$

$$=-\tfrac{1}{2}\frac{1\pm ma}{p}=\phi$$

Other cases are possible, though occurring very infrequently.

2 Arnold, *Die Gleichstrommaschine.*

In the formula for w_e the absolute value of ϕ with the positive sign is always to be substituted. The required width of the auxiliary pole face will be: $w_i = w_e$ — double auxiliary air gap.

$$w_i = \left(b - \frac{a}{p} + m + \phi\right)\beta - 2\delta_i$$

In order to make ϕ a minimum, y_1 has to be made as nearly as possible equal to the pole pitch; the good practice for non-interpole machines, of shortening the winding pitch, therefore, has to be abandoned for auxiliary-pole machines.

The preceding formulae have been deduced for a series-wound armature; for a multiple winding, however, the same results will be obtained, so that the formulae are correct in every case.

Proceeding now to the determination of the formula for the reactance electromotive force, the basis is the well known formula for an electromotive force of self induction:

$$e_r = L\,\frac{di}{dt}$$

or better:

$$e_r = (L + M)\,\frac{di}{dt}$$

where L is the coefficient of self induction and M the coefficient of mutual induction; in our case, where we will determine L and M at the same time, we use the formula:

$$e_r = L'\,\frac{di}{dt}$$

where $L' = L + M$.

i = current in the short-circuited coil.

t = time.

L' must be determined from the magnetomotive forces and magnetic reluctances of the short-circuit zone. In calculating the different leakage fluxes around the short-circuited coil and considering a line of force going partly through air and partly through iron, the magnetic reluctance of the latter will be neglected and the air reluctance only will be taken into account.

Conveniently L' may be divided into four parts (Fig. 12):

(1) A flux crossing the slot.

(2) A flux going through the air outside of the armature from one tooth to the next, over a part of the armature of a length $l_a - l_i$ (l_i = length of auxiliary pole).

(3) A flux flowing through the auxiliary air gap (twice) and the interpole tip (Fig. 13).

(4) A flux flowing around the coil where the coil is outside of the armature iron.

L' will be determined for the case in which the upper and lower part of a slot, containing only two coils, commutate at the same time, after that this will be corrected so as to take into account the actual conditions. The commutation of a certain coil is not influenced by short-circuited coils lying in slots next to the one which is under consideration.

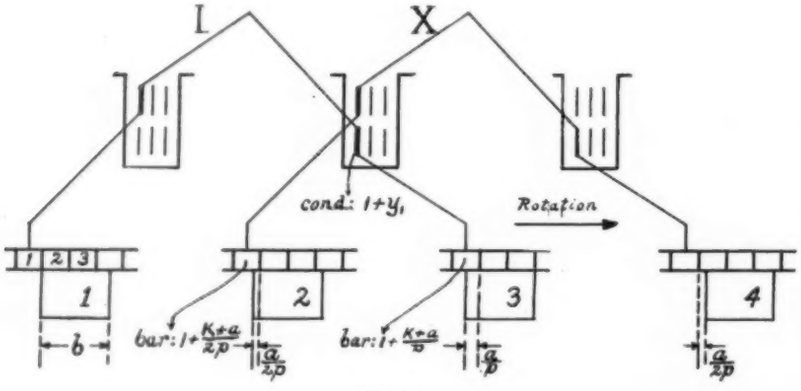


FIG. 11.

(1) Let W = the number of turns per coil, hence the magnetomotive force, for a current of one ampere flowing through the short-circuited coil, working on the section dx (Fig. 12) is equal to[3]:

$$0.4\,\pi\,2W\,\frac{x}{N_t}$$

the magnetic reluctance of this section is:

$$\frac{N_b}{2\,l_a dx}$$

and thus the flux through the path dx is:

$$\frac{0.4\,\pi\,2W\,2\,l_a\,x\,dx}{N_b\,N_t}$$

This flux, when changing, will induce an electromotive force in xW/N_t turns, and therefore this electromotive force for one ampere change in current per second will be

$$\frac{0.4\,\pi\,2W\,2\,l_a\,x\,dx}{N_b\,N_t}\,W\,\frac{x}{N_t}$$

and for the entire slot:

$$L_1 = \frac{0.4\,\pi\,2W^2\,2\,l_a}{N_b\,N_t}\int_{x=0}^{x=N_t} x^2\,dx$$

$$= \frac{5.02\,W^2\,l_a}{N_b\,N_t^3}\,\frac{N_t^3}{3} = 1.675\,l_a\,\frac{N_t}{N_b}\,W^2$$

(2) The magnetomotive force, for the lines of force going across the top of the considered slot from top to top of the teeth on either side of the slot through the surrounding air, is constant for different values of y (Fig. 12) being:

$$0.4\pi \times 2W.$$

the magnetic reluctance is:

$$\frac{\pi\,y}{2\,(l_a - l_i)\,dy}$$

and thus the flux:

$$\frac{0.4\,\pi\,2W\,2\,(l_a - l_i)\,dy}{\pi\,y}$$

this flux integrated from $y = N_b/2$ to $y = u - N_b/2$ (u = tooth pitch = $\pi d_a/Z$) will induce an electromotive force for a change in current of one ampere per second, equal to:

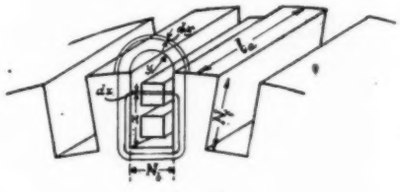


FIG. 12.

$$L_2 = 1.6\,W^2\,(l_a - l_i)\,\log_\epsilon \frac{u - \frac{N_b}{2}}{\frac{N_b}{2}}$$

$$= 3.68\,W^2\,(l_a - l_i)\,\log_{10}\frac{2u - N_b}{N_b}$$

(3) In the position of the slot under the auxiliary pole as shown by Fig. 13, the magnetic reluctance is:

$$\frac{2\,\delta_i}{2\,l_i\,\frac{w_i - N_b}{2}}$$

and:

$$L_3 = \frac{0.4\,\pi\,2W^2\,2\,l_i\,\frac{w_i - N_b}{2}}{2\,\delta_i}$$

$$= 1.25\,l_i\,W^2\,\frac{w_i - N_b}{\delta_i}$$

When the center line of the slot is in the center line of the auxiliary pole this magnetic reluctance is a minimum; it is a maximum when the slot is under an auxiliary pole tip. Assuming that this reluctance varies according to a sine wave, we must divide the preceding

[3] Prenzlin, *Elektrotechnische Zeitschrift, 1902.*

value for L_3 by $\sqrt{2}$ in order to get the average value[4], so that:

$$L_3 = 0.8\, l_i\, W^2\, \frac{w_i - N_b}{\delta_i}$$

(4) For the part of the coil outside of the armature iron, we assume to have 0.8 maxwell per ampere conductor per centimeter[5], with l_s = free length per conductor (in centimeters) outside of the armature iron,

$$L_4 = 1.6 l_s W^2.$$

In using the formulas for L as given heretofore the result will be in C. G. S. units; in order to obtain L expressed in practical units of self-induction (henry) the foregoing results have to be divided by 10^8, and thus:

$$L' = (L_1 + L_2 + L_3 + L_4)10^{-8}$$
$$= \frac{W^2}{10^8}\left[1.675\, l_a \frac{N_t}{N_b} + 3.68\,(l_a - l_i)\log\frac{2u - N_b}{N_b} + 0.8\, l_i \frac{w_i - N_b}{\delta_i} + 1.6 l_s\right]$$

Our attention is called now to the determination of the other factor, influencing the reactance electromotive force, namely, di/dt. In determining this factor we will make the only assumption, not quite agreeing with the actual conditions, *i. e.*, that di/dt is a constant, which means that we assume to have a straight-line commutation. On an interpole machine, however, where we make the strength of the auxiliary-pole field such as to cause a level brush-potential curve, we will have very little additional short-circuit currents and therefore very nearly a straight-line commutation. As will be shown afterwards, this assumption will to a larger extent agree with the actual condition for the case where we have a small number of commutator bars (one or two) per slot.

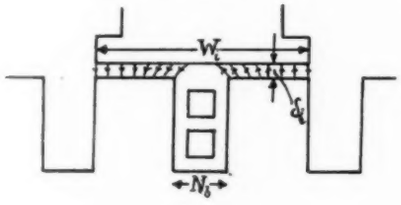


FIG. 13.

The way to determine di/dt will be shown with the following example:

Let $m = 3$,
$p = 2$,
$a = 1$ (series winding),
$b = 1.75\,\beta$.
v = revolutions per second.
A = length (in commutator bars) of the short-circuit zone of one coil $= b + 1 - a/p = 2.25$.
i = armature current per circuit $= I/2a$.
I = total armature current.

For one coil, not taking into account the influence of the other coils:

$$\frac{di}{dt} = \frac{2i}{t} = \frac{2i}{\frac{A}{Kv}} = \frac{2iKv}{A}$$

Fig. 14a shows for this example how the current volume of the upper part of a slot, containing three coils, changes from $+3i$ to $-3i$; from a to b and from e to f only one coil is in short-circuit, from b to c and from d to e two coils are in short-circuit, and from c to d all three coils are in short-circuit. The reactance voltage in any of these three coils, not considering the influence of the lower part of the slot, when proceeding through the short-circuit zone is shown by Fig. 14b, the coils being in short-circuit during the periods as indicated by 1, 3 and 5. The average value of di/dt for the three coils will be:

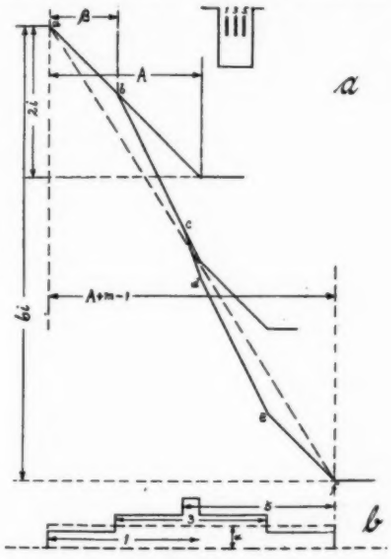


FIG. 14.

$$K\, v\, \frac{6\,i}{4.25} = 1.41\, Kvi$$

or in general:

$$\frac{di}{dt} = a\, Kvi$$

where

$$a = \frac{2\,m}{A + m - 1}$$

The actual values, however, are shown in Fig. 14b. Considering now the coils in the lower half of the slot, it is obvious that the reactance voltage in those coils will change in the same way as that in the upper coils when the influence of both parts on each other is not taken into account. Relatively, however, the commutation begins Φ/Kv seconds before or after the beginning of commutation in the upper part. The influence of both parts on each other could be shown in the same way as done in Fig. 14 for one-half of a slot by taking care of all the coils in a slot. The same effect is obtained by adding to the ordinates of Fig. 15a (representing the upper part of a slot) the corresponding ordinates of Fig. 15b (representing the lower half); the result is shown in Fig. 15c. Fig. 15 has been worked out for the same example as used for Fig. 14 with $\phi = 3/4$ (of one commutator bar). The ordinates of Fig. 15c represent on a certain scale the reactance voltage in the different coils of the slot, each coil being in short-circuit as indicated.

In order to induce in the short-circuited coil a voltage equal and opposite to the reactance electromotive force, the flux-density in each point of the interpole air gap ought to be proportionate to the reactance voltage at that point, which shows that the auxiliary pole-shoe may be advantageously shaped approximately as the shaded part of Fig. 15c or to be exact, the air gap at each point of the commutating zone must be inversely proportional to the reactance voltage in that point.

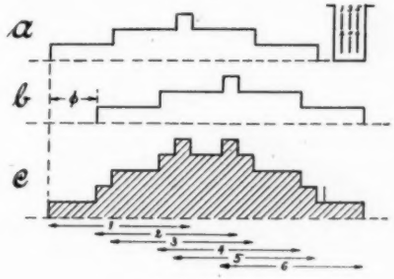


FIG. 15.

In finding the coefficient of self and mutual induction we assumed the upper and lower part of a slot to commutate at the same time; considering only either one of the two parts we will halve the found value and in order to take care of the mutual influence of both parts in the proper way, we will multiply with another factor, which is to be found now.

Assuming we have a slot with only two coils, an upper and a lower one, both being in short-circuit over $(A + m - 1)$ commutator bars, one starting to commutate when the other has advanced over ϕ bars in the commutating zone, the reactance voltage in either of

4 Arnold, *Die Gleichstrommaschine.*
5 According to Hobart.

the two coils, on account of the influence of the other, has to be multiplied by (Fig. 16):

$$\frac{2i + \frac{A+m-1-\phi}{A+m-1}\,2i}{\frac{2i}{A+m-1}} = 1 + \frac{A+m-1-\phi}{A+m-1}$$

$$= 2 - \frac{\phi}{A+m-1}$$

The condition is that

$$\phi \leq A + m - 1$$

which will always be the case for auxiliary-pole machines. For $\phi = 0$ the value of this factor is equal to 2, and for $\phi = A + m - 1$ when the one part does not influence the other part at all, this factor will be equal to 1.

The influence of the different phenomena being determined, the formula for the reactance electromotive force can be found as follows:

$$e_r = L' \frac{di}{dt}$$

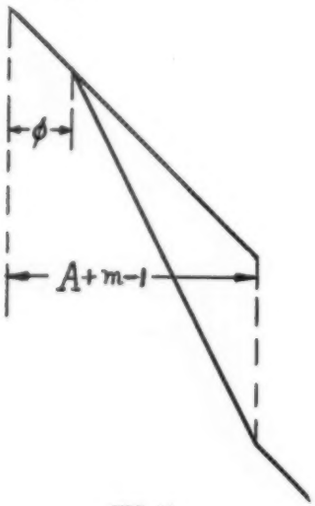


FIG. 16.

L' for either upper or lower part of a slot is:

$$L' = \frac{W^2}{2 \cdot 10^8}\left[1.675\, l_a \frac{N_t}{N_b} + 3.68\,(l_a - l_i)\log\frac{u - N_b}{N_b} + 0.8\, l_i \frac{w_i - N_b}{\delta_i} + 3.2\, l_a\right]$$

taking into account the influence of the other part:

$$L' = \frac{W^2}{2 \cdot 10^8}\left[\left(2 - \frac{\phi}{A+m-1}\right)\left(1.675\, l_a \frac{N_t}{N_b} + 3.68\,(l_a - l_i)\log\frac{u - N_b}{N_b} + 0.8\, l_i \frac{w_i - N_b}{\delta_i}\right) + 3.2\, l_a\right]$$

$$= \frac{W^2}{2 \cdot 10^8} M$$

$$\frac{di}{dt} = K v i \frac{2m}{A+m-1}$$

Thus:

$$e_r = \frac{K v i W^2}{2 \cdot 10^8} \frac{2m}{A+m-1} M$$

KWi = total number of ampere-turns on armature = T.

$$e_r = \frac{v W T}{10^8} \frac{m}{A+m-1} M$$

With the different dimensions in inches instead of in centimeters, the result must be multiplied by 2.54.

The density in the auxiliary-pole gap can be determined now by the consideration that this density has to be such as to induce in the short-circuited coil an electromotive force equal and opposite to the reactance voltage.

$$e_r = 2 W B_i l_i s 10^{-8}$$

where B_i is in maxwells per square centimeter, l_i is in centimeters, s is in centimeters per second.

If we take B_i^1 in maxwells per square inch, l_i^1 in inches, s^1 in feet per second, then $e_r = 2 W B_i^1\ l_i^1\ s^1\ 12.0 \times 10^{-8}$ by which formula B_i^1 can be determined. The required amount of ampere-turns per auxiliary pole can be found quite easily, provided the path of the auxiliary flux is unsaturated, by the expression:

$$\frac{T}{2p} + 0.3175\, B_i'\, \delta_i'\, K_1$$

δ_i' is in inches; by multiplying with K_1 the increase in air gap, caused by the presence of slots under the auxiliary pole is taken into account; this factor, as given by Professor Arnold, may be taken from Fig. 17. Taking for di/dt the average value for all the coils of a slot, the formula for the reactance voltage also gives the average value; in using a straight interpole face, it is the experience of the author that in deriving the auxiliary ampere-turns as done before, good results are obtained; in case, however, that the auxiliary pole tips are chamfered, and to take the extreme case, are chamfered so as to make the air density in each point proportional to the reactance electromotive force in that point (Fig. 15c) then the required auxiliary excitation may be derived from the maximum reactance voltage and the factor $m/(A + m - 1)$ has to be changed to m'/A where m' = maximum number of coils in a slot being in short-circuit at the same time. The value to be substituted for δ_i, of course, has to be taken at the same point of the commutating zone, where the maximum reactance electromotive force prevails.

It must be borne in mind that the reactance electromotive force as given means this voltage for one coil; for an auxiliary-pole machine this is satisfactory as thereafter the voltage, induced in the short-circuited coil by the interpole flux, is also calculated for one coil. For a non-interpole machine the formula may be used also, provided the following changes are made: p/a short-circuited coils being connected in series, the reactance voltage, as found according to the preceding formula, has to be multiplied by p/a; in the factor accounting for the leakage between two teeth l_i is to be taken as zero, and the factor $0.8\, l_i\ (w_i - N_b)/\delta_i$ is to be omitted.

In case half the number of auxiliary poles is omitted, the formulæ have to be used in the following form:

$$e_r = \frac{W T v}{10^{-8}} \frac{m}{A+m-1}\left[\left(2 - \frac{\phi}{A+m-1}\right)\left(1.675\, l_a \frac{N_t}{N_b} + 1.84\,(2 l_a - l_i)\log\frac{u - N_b}{N_b} + 0.4\, l_i \frac{w_i - N_b}{\delta_i}\right) + 3.2\, l_a\right]$$

$$e_r = W B_i l_i s\ 10^{-8}$$

Fig. 15 is a very important one and should always be made in cases of difficult commutating conditions; it shows clearly that with a constant air gap all over the width of the auxiliary pole

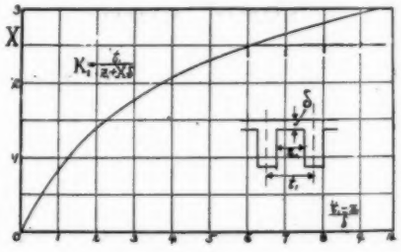


FIG. 17.

perfect commutation may not be expected, although sparking need not necessarily occur. The shape of this reactance-voltage curve also shows why a good effect often is obtained by bevelling the auxiliary poles, it being very possible that with a straight interpole tip and the proper field strength in the center of the commutating zone, the commutating field is too strong, towards the ends of the short-circuit zone. However, only in case of very difficult commutation conditions should *the auxiliary pole tips* be bevelled, as this will make the machine more sensitive as to the correct brush position.

Absolutely perfect commutation, *i. e.*, constant reactance voltage all over the commutating zone is only possible with one commutator bar per slot and with

$\phi = 0$; with two coils per slot the auxiliary pole may eventually be shaped so as to very nearly give perfect commutation. With three or more coils per slot perfect commutation is hardly possible; the deviation from the perfect condition, however, may be within certain limits so as not to cause sparking. The method for calculating the auxiliary ampere-turns does not show any more difficulty for a 550-volt than for a 115-volt machine, or for a machine with five coils per slot than for one with only one coil per slot. Every designer, however, knows that these difficulties actually exist; the preceding shows that they are caused by the irregular shape of the commutation curve. It is even not necessary that when sparkless commutation is not obtained, this must be shown up by the brush-potential curve; this curve, being an average for all the coils of a slot, need not show the effect of some additional short-circuit currents that flow in part of those coils or in all of them, but possibly of such direction and intensity that the average value of the brush potential is not influenced.

The required interpole excitation has been found for the case that the path

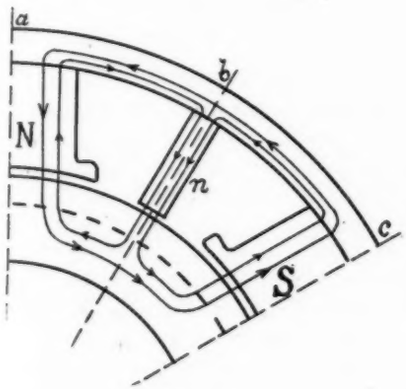


FIG. 18.

of the auxiliary flux is unsaturated; when this path, or part of it, is saturated, however, it is of advantage to determine the saturation curve of the auxiliary poles and to take the required number of ampere-turns according to this curve.

The distribution of the interpole flux in a machine with as many auxiliary as main poles may be supposed to be known. The flux-density in main poles and in the air gaps under the main poles is not influenced by the auxiliary poles, or better, the total influence of all the auxiliary poles on a main pole is equal to zero. As for the yoke, the flux-density will be partly increased, partly decreased. In the part ab (Fig. 18) the density will be decreased by an amount equal to one-half of the auxiliary flux per pole divided by the cross section of yoke. In the part bc the

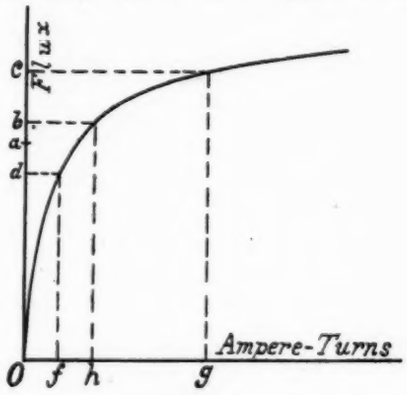


FIG. 19.

density will be increased by the same amount. This is only quite correct in the case of an unsaturated machine; when saturated the distribution will be such so as to cause the resultant magnetic reluctance to be minimum. However, in figuring as indicated before, the results will be nearly enough correct.

In order to find the proper amount of ampere-turns required to force the auxiliary flux through the yoke, it is necessary to plot the saturation curve of the yoke.[6] We assume the normal flux for the machine to be Oa (Fig. 19) and the flux in the yoke, on account of leakage, Ob. The auxiliary flux, including leakage, will be dc, so that the induction in the different yoke parts will be Od and Oc (bc = bd) and the corresponding ampere-turns, Of and Og. Whereas without auxiliary poles, we needed over the entire length of the yoke, Oh ampere-turns per circuit, we need with auxiliary poles Of/2 in half of the yoke and in the other half Og/2 ampere-turns and thus there are required on account of the presence of the auxiliary poles (Og+Of)/2 — Oh ampere-turns, more than without auxiliary poles.

The required number of ampere-turns for the interpole core may be calculated in the usual way, taking proper care of the leakage; plotting these values and the ones obtained by the preceding construction together with the required ampere-turns for the air gap, the saturation curve for the auxiliary poles will be obtained (Fig. 8).

6 Arnold, *Die Gleichstrommaschine.*

In discussing the method for finding the interpole saturation curve, the leakage of the auxiliary poles has been mentioned; this important factor may vary from 80 to 300 per cent, a value of 75 to 150 per cent being very usual. In order to keep this leakage flux as small as possible, the width of the interpole should not be made greater than strictly necessary, and the length of the auxiliary pole should be made shorter than the armature, without running the induction in the auxiliary core up too high. If due attention is paid to the matter of saturation, the auxiliary pole may advantageously be made shorter than the armature (1) from a point of view to decrease the leakage flux and (2) in order to save copper.

In regard to the leakage of the auxiliary poles, which will be a maximum near to the armature, between auxiliary pole tip and main pole tip, it may be recommended to bevel the auxiliary poles (Fig. 20) which will diminish the leakage and at the same time have a good effect concerning the commutation curve, as spoken of before.

When half of the full number of auxiliary poles is omitted, the flux distribution in the magnet system is different from the distribution in a machine with the full number of auxiliary poles. In order to show this difference the magnet system of a direct-current machine will be compared with a system of electromotive forces, interconnected by re-

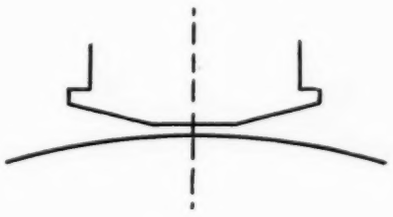


FIG. 20.

sistances. This comparison is correct for the case of an unsaturated machine (an auxiliary-pole machine in general is only slightly saturated). A two-pole machine with two auxiliary poles will be represented by the scheme as shown in Fig. 21, the electromotive forces E representing the magnetomotive forces of the main poles, e those of the auxiliary poles. The resistances R, r, r_1 and r_2 are the equivalent of the magnetic reluctances and the currents I_1, I_2, I_3, I_4 and $i_1 \ldots\ldots i_8$ the equivalent of the magnetic fluxes. The values of the different currents may be found by appli-

cation of the rules of Ohm and Kirchhoff. The results follow:

(1) Without interpoles.

$$I_1 = I_2 = \frac{2E}{2R + r_1 + r_2}$$

$$i = \frac{E}{2R + r_1 + r_2}$$

(2) With two interpoles.

$$I_1 = I_2 = \frac{2E}{2R + r_1 + r_2}$$

$$I_3 = I_4 = \frac{2e}{2r + r_1 + r_2}$$

$$i_1 = i_3 = i_5 = i_7 = \frac{E}{2R + r_1 + r_2} + \frac{e}{2r + r_1 + r_2}$$

$$i_2 = i_4 = i_6 = i_8 = \frac{E}{2R + r_1 + r_2} - \frac{e}{2r + r_1 + r_2}$$

(3) With one interpole (the "e" in the left half is omitted).

$$I_1 = \frac{2E}{2R + r_1 + r_2} + \frac{e}{R + 2r + r_1 + r_2}$$

$$I_2 = \frac{2E}{2R + r_1 + r_2} - \frac{e}{R + 2r + r_1 + r_2}$$

$$I_3 = \frac{2e}{R + 2r + r_1 + r_2}$$

$$i_2 = i_3 = i_6 = i_7 = \frac{E}{2R + r_1 + r_2}$$

$$i_1 = i_5 = \frac{E}{2R + r_1 + r_2} + \frac{e}{R + 2r + r_1 + r_2}$$

$$i_4 = i_8 = \frac{E}{2R + r_1 + r_2} - \frac{e}{R + 2r + r_1 + r_2}$$

The comparison of these formulæ shows, as was stated previously, that the flux in the main poles is the same in a machine with the full number of interpoles as in a machine without interpoles; with half the full number of auxiliary poles, however, the flux is increased or decreased with half the flux of an auxiliary pole; also the flux density in the yoke, between two main poles where the auxiliary pole is omitted, will in the latter case be equal to the yoke density of the same machine without auxiliary poles.

In plotting the auxiliary saturation curve for a machine with half the full number of auxiliary poles, proceedings are the same as for a machine with the full number of auxiliary poles, with the exception that care is to be taken of the ampere-turns required to force half the auxiliary flux through the main air gap and through the main poles.

A misunderstanding is possible in regard to that part of the construction of the interpole saturation curve which refers to the method of Professor Arnold for finding the increase in excitation required for magnetizing the yoke and caused by the application of interpoles. These ampere-turns are not to be supplied by the interpole coils, but mean an increase to that amount in the main-pole excitation in order to maintain the same main flux. The ampere-turns that are required to bring about the change in density in the two yoke parts and which are to be supplied by the interpole coils can be found by a similar construction.

The formulæ found by the comparison of a magnet system with a system of electromotive forces and resistances

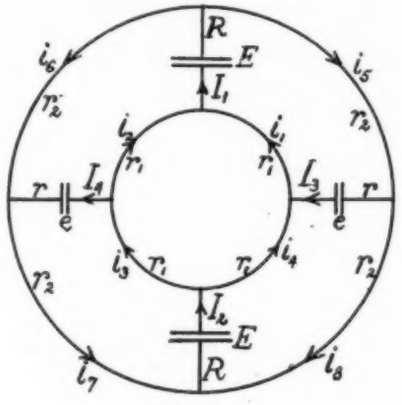


FIG. 21.

show that the two halves of the part of the yoke and of the armature core between two main poles, are connected in parallel in regard to the interpole excitation. That part of the interpole ampere-turns which is to supply the excitation necessary to bring about the change in yoke density, is the same for both halves of the yoke; the increase in density in the one half on account of saturation will not be as large as the decrease in density in the other half. Fig. 22 shows the saturation curve of the yoke; with a main-pole excitation equal to Oa and without interpoles the

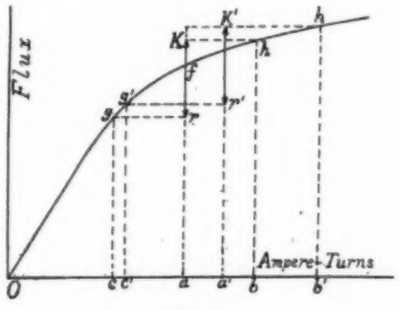


FIG. 22.

main flux will be equal to af. With interpoles, however, and with an amount of ampere-turns per interpole available for magnetizing the yoke equal to ab = ac, the flux in one part will be equal to bh and in the other part equal to cg, the difference bh — cg representing the flux per interpole. Thus the weakening of the main flux, caused by the interpole flux, will be in the proportion bh+cg: 2 af.

The interpole flux and the main-pole excitation Oa being known, and the amount of interpole ampere-turns required for magnetizing the yoke to be found, the construction is to be made as follows.

The interpole flux Kr is to be located on the line af so that when the points K and r are projected horizontally on the saturation curve, the amounts of ampere-turns ab and ac are equal to each other. At the same time, however, the main flux has decreased in the proportion as shown before.

If it is desired to find main and auxiliary ampere-turns required to drive a certain main flux and a certain auxiliary flux through the yoke, the points h′ and g′ are to be located on the saturation curve so as to make:

b′h′ = main flux + ½ interpole flux = af + Kr/2.

c′g′ = main flux — ½ interpole flux = af — Kr/2.

a′ being in the middle between b′ and c′ gives the required interpole excitation equal to a′b′ = a′c′. Whereas Professor Arnold's method gives the exact results as far as the increase in main flux excitation is concerned, it does not show the proper distribution of the interpole flux in the yoke.

It is obvious that all that is said about the yoke applies also to the armature core.

Increase in Maryland's Coal Output.

The production of coal in Maryland in 1910 was 5,217,125 short tons, with a spot value of $5,835,058, according to statistics collected by the United States Geological Survey in co-operation with the Maryland Geological Survey. Owing to the shortage of fuel in the Western States a large amount of West Virginia coal, particularly from the southern part of the state, was delivered from the seaboard to the more profitable markets in the West. Profiting by this diversion, Virginia's production, shipped principally to Lambert Point piers near Norfolk, increased over 1,750,000 tons, or 37 per cent.

Maryland's coal production, which because of the approaching exhaustion of the famous "Big vein," had been showing a declining tendency for the last two years, was also given an impetus by the trade conditions in 1910 and increased from that of 1909 by 1,193,884 tons, or 29.67 per cent. The value increased $1,363,327, or 30.5 per cent.

TESLA'S NEW METHOD OF AND APPARATUS FOR FLUID PROPULSION.

INVENTION OF A TURBINE AND PUMP.

In an address before the New York section of the National Electric Light Association on May 15 of this year, Nikola Tesla devoted a few remarks to a new mechanical principle he had developed, and exhibited diagrams and working drawings in explanation of the same. He also alluded to the fact that several of his machines were to be seen in operation at the Waterside Station of the New York Edison Company, which had courteously extended to Dr. Tesla its facilities. The ELECTRICAL REVIEW AND WESTERN ELECTRICIAN of May 20 published an exclusive and full report of Dr. Telsa's address.

We present herewith the first authoritative description in the inventor's own words, which, on account of the great importance of the subject, cannot fail to excite interest in engineering circles the world over.

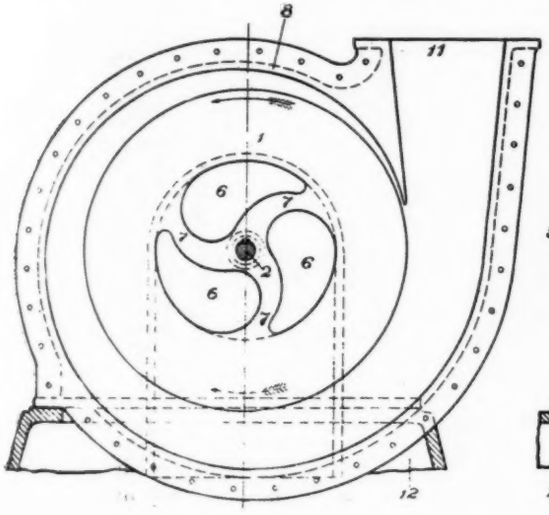


FIG. 1.

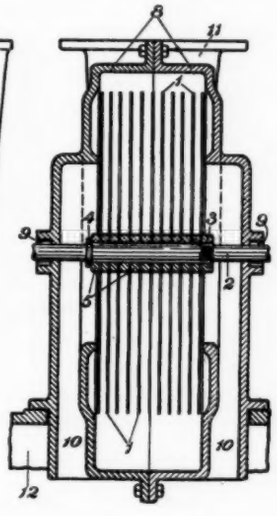


FIG. 2.

In the practical application of mechanical power based on the use of a fluid as vehicle of energy it has been demonstrated that, in order to attain the highest economy, the changes in velocity and direction of movement of the fluid should be as gradual as possible. In the present forms of such apparatus more or less sudden changes, shocks and vibrations are unavoidable. Besides, the employment of the usual devices for imparting to, or deriving energy from a fluid, as pistons, paddles, vanes and blades, necessarily introduces numerous defects and limitations and adds to the complication, cost of production and maintenance of the machine.

The purpose of the invention is to overcome these deficiencies and to effect the transmission and transformation of mechanical energy through the agency of fluids in a more perfect manner, and by means simpler and more economical than those heretofore employed.

This is accomplished by causing the propelled or propelling fluid to move in natural paths or stream lines of least resistance, free from constraint and disturbance such as occasioned by vanes or kindred devices, and to change its velocity and direction of movement by imperceptible degrees, thus avoiding the losses due to sudden variations while the fluid is receiving or imparting energy.

It is well known that a fluid possesses, among others, two salient properties; adhesion and viscosity. Owing to these a body propelled through such a medium encounters a peculiar impediment known as "lateral," or "skin resistance," which is twofold: one arising from the shock of the fluid against the asperities of the solid substance, the other from internal forces opposing molecular separation. As an inevitable consequence a certain amount of the fluid is dragged along by the moving body. Conversely, if the body be placed in a fluid in motion, for the same reasons, it is impelled in the direction of movement. The accompanying drawings illustrate operative and efficient embodiments of the idea.

Fig. 1 is a partial end view, and Fig. 2 a vertical cross-section of a pump or compressor, while Figs. 3 and 4 represent, respectively, in corresponding views, a rotary engine or turbine, both machines being constructed and adapted to be operated in accordance with the invention.

Figs. 1 and 2 show a runner composed of a plurality of flat rigid disks *1* of a suitable diameter, keyed to a shaft *2* and held in position by a threaded nut *3*, a shoulder *4* and washers *5* of the requisite thickness. Each disk has a number of central openings *6*, the solid portions between which form spokes *7* preferably curved, as shown, for the purpose of reducing the loss of energy due to the impact of the fluid.

This runner is mounted in a two-part volute casing *8* having stuffing boxes *9* and inlets *10* leading to its central portion. In addition a gradually widening and rounding outlet *11* is provided formed with a flange for connection to a pipe as usual. The casing *8* rests upon a base *12* shown only in part and supporting the bearings for the shaft 2, which, being of ordinary construction, are omitted from the drawings.

An understanding of the principle embodied in this apparatus will be gained from the following description of its mode of operation.

Power being applied to the shaft and the runner set in rotation in the direction of the solid arrow, the fluid, by reason of its properties of adherence and viscosity, upon entering through the inlets *10* and coming in contact with the disks *1* is taken hold of by the same and subjected to two forces, one acting tangentially in the direction of rotation, and the other radially outward. The combined effect of these tangential and centrifugal forces is to propel the fluid with continuously increasing velocity in a spiral path until it reaches the outlet *11* from which it is ejected. This spiral movement, free and undisturbed and essentially dependent on these properties of the fluid, permitting it to adjust itself to natural paths or stream lines and to change its velocity and direction by insensible degrees, is characteristic of this method of propulsion and advantageous in its application.

While traversing the chamber inclosing the runner, the particles of the fluid may complete one or more turns, or but a part of one turn. In any given case their path can be closely calculated and graphically represented, but fairly accurate estimates of turns can be obtained simply by determining the number of revolutions required to renew the fluid passing through the chamber and multiplying it by the ratio between the mean speed of the fluid and that of the disks.

It has been found that the quantity of fluid propelled in this manner is, other conditions being equal, approximately proportionate to the active surface of the runner and to its effective speed. For this reason, the performance of such machines augments at an exceedingly high rate with the increase of their size and speed of revolution.

The dimensions of the apparatus as a whole, and the spacing of the disks in any given machine, will be determined by the conditions and requirements of special cases. It may be stated that the intervening distance should be the greater, the larger the diameter of the disks, the longer the spiral path of the fluid and the greater its viscosity. In general, the spacing should be such that the entire mass of the fluid, before leaving the runner, is accelerated to a nearly uniform velocity, not much below that of the periphery of the disks under normal working conditions and almost equal to it when the outlet is closed and the particles move in concentric circles.

It may also be pointed out that such a pump can be made without openings and spokes in the runner, as by using one or more solid disks, each in its own casing, in which form the machine will be eminently adapted for sewage, dredging and the like, when the water is charged with foreign bodies and spokes or vanes are especially objectionable.

Another application of this principle, thoroughly practicable and efficient, is the utilization of machines such as described for the compression or rarefaction of air, or gases in general. In such cases most of the general considerations obtaining in the case of liquids, properly interpreted, hold true.

When, irrespective of the character of the fluid, considerable pressures are desired, staging or compounding may be resorted to in the usual way, the individual runners being, preferably, mounted on the same shaft. It should be added that the same end may be attained with one single runner by suitable deflection of the fluid through rotative or stationary passages.

The principles underlying the invention are capable of embodiment also in that field of mechanical engineering which is concerned in the use of fluids as motive agents, for while in some respects the actions in the latter case are directly opposite to those met with in the propulsion of fluids, the fundamental laws applicable in the two cases are the same. In other words, the operation above described is reversible, for if water or air under pressure be admitted to the opening *11* the runner is set in rotation in

the direction of the dotted arrow by reason of the peculiar properties of the fluid which, traveling in a spiral path and with continuously diminishing velocity, reaches the orifices *6* and *10* through which it is discharged. If the runner be allowed to turn freely, in nearly frictionless bearings, its rim will attain a speed closely approximating the maximum of that of the fluid in the volute channel and the spiral path of the particles will be comparatively long, consisting of many almost circular turns. If the load is put on and the runner slowed down, the motion of the fluid is retarded, the turns are reduced, and the path is shortened.

Owing to a number of causes affecting the performance, it is difficult to frame a precise rule which would be generally applicable, but it may be stated that within certain limits, and other conditions being the same, the torque is directly proportional to the square of the velocity of the fluid relatively to the runner and to the effective area of the disks and, inversely, to the distance separating them. The machine will, generally, perform its maximum work when the effective speed of the runner is one-half of that of the fluid. But to attain the highest economy the relative speed or slip, for any given performance, should be as small as possible. This condition may be to any desired degree approximated by increasing the active area and reducing the space between the disks.

When apparatus of the kind described is employed for the transmission of power, certain departures from similarity between transmitter and receiver may be necessary for securing the best result. It is evident that, when transmitting power from one shaft to another by such machines, any desired ratio between the speeds of rotation may be obtained by proper selection of the diameters of the disks, or by suitably staging the transmitter, the receiver, or both. But it may be pointed out that in one respect, at least, the two machines are essentially different. In the pump, the radial or static pressure, due to centrifugal force, is added to the tangential or dynamic, thus increasing the effective head and assisting in the expulsion of the fluid. In the motor, on the contrary, the first named pressure, being opposed to that of supply, reduces the effective head and the velocity of radial flow towards the center. Again, in the propelled machine a great torque is always desirable, this calling for an increased number of disks and smaller distance of separation, while in the propelling machine, for numerous economic reasons, the rotary effort should be the smallest and the speed the greatest practicable. Many other considerations, which will naturally suggest themselves, may affect the design and construction, but the preceding is thought to contain all necessary information in this regard.

The greatest value of this invention will be found in its use for the thermodynamic conversion of energy. Reference is now made to Figs. 3 and 4, illustrative of the manner in which it is, or may be, so applied.

As in the previous figures, a runner is provided made up of disks *13* with openings *14* and spokes *15* which, in this case, may be straight. The disks are keyed to and held in position on a shaft *16*, mounted to turn freely in suitable bearings, not shown, and are separated by washers *17* conforming in shape with the spokes and firmly united thereto by rivets *18*. For the sake of clearness but a few disks, with comparatively wide intervening spaces, are indicated.

The runner is mounted in a casing comprising two end-castings *19* with outlets *20* and stuffing boxes *21*, and a central ring *22*, which is bored out to a circle of a diameter slightly larger than that of the disks, and has flanged extensions *23* and inlets *24* into which finished ports, or nozzles *25* are inserted. Circular grooves *26* and labyrinth packings *27* are provided on the sides of the runner. Supply pipes *28*, with valves *29*, are connected to the flanged extensions of the central ring, one of the valves being normally closed.

With the exception of certain particulars, which will be elucidated, the mode of operation will be understood from the preceding description. Steam or gas under pressure being allowed to pass through the valve at the side of the solid arrow, the runner is set in rotation in clockwise direction.

In order to bring out a distinctive feature assume, in the first place, that the motive medium is admitted to the disk chamber through a port, that is, a channel which it traverses with nearly uniform velocity. In this case, the machine will operate as a rotary engine, the fluid continuously expanding on its tortuous path to the central outlet. The expansion takes place chiefly along the spiral path, for the spread inward is opposed by the centrifugal force due to the velocity of whirl and by the great resistance to radial exhaust. It is to be observed that the resistance to the passage of the fluid between the plates is approximately proportional to the square of the relative speed, which is maximum in the direction towards the center and equal to the full tangential velocity of the fluid. The path of least resistance, necessarily taken in obedience to a universal law of motion, is virtually, also that of least relative velocity.

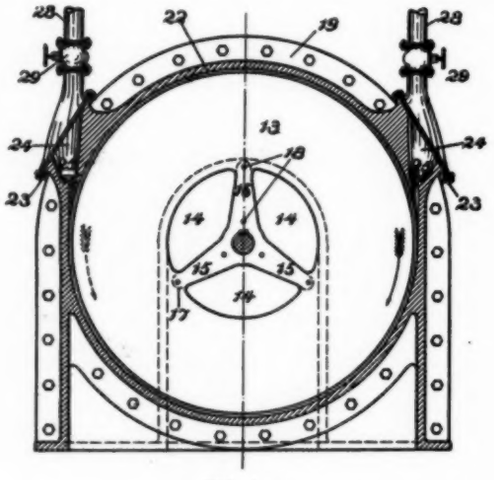


FIG. 3.

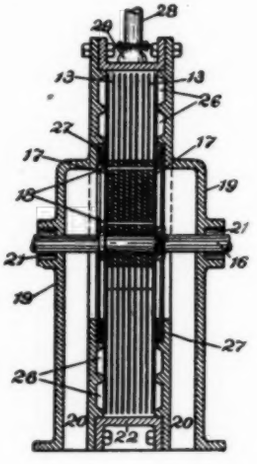


FIG. 4.

Next, assume that the fluid is admitted to the disk chamber not through a port, but a diverging nozzle, a device converting, wholly or in part, the expansive energy into velocity-energy. The machine will then work rather like a turbine, absorbing the energy of kinetic momentum of the particles as they whirl, with continuously decreasing speed, to the exhaust.

The above description of the operation is suggested by experience and observation and is advanced merely for the purpose of explanation. The undeniable fact is that the machine does operate, both expansively and impulsively. When the expansion in the nozzle is complete, or nearly so, the fluid pressure in the peripheral clearance space is small; as the nozzle is made less divergent and its section enlarged, the pressure rises, finally approximating that of the supply. But the transition from purely impulsive to expansive action may not be continuous throughout, on account of critical states and conditions, and comparatively great variations of pressure may be caused by small changes of nozzle velocity.

In the preceding it has been assumed that the pressure of supply is constant or continuous, but it will be understood that the operation will be, essentially, the same if the pressure be fluctuating or intermittent, as that due to explosions occurring in more or less rapid succession.

A very desirable feature, characteristic of machines constructed and operated in accordance with this invention, is their capability of reversal of rotation. Fig. 3, while illustrative of a special case, may be regarded as typical in this respect. If the right hand valve be shut off and the fluid supplied through the second pipe, the runner is rotated in the direction of the dotted arrow, the operation, and also the performance, remaining the same as before, the central ring being bored to a circle with this purpose in view. The same result may be obtained in many other ways by specially designed valves, ports or nozzles for reversing the flow, the description of which is omitted here in the interest of simplicity and clearness. For the same reasons but one operative port or nozzle is illustrated, which might be adapted to a volute but does not fit best a circular bore. It is evident that a number of suitable inlets may be provided around the periphery of the runner to improve the action and that the construction of the machine may be modified in many ways.

Still another valuable and probably unique quality of such motors or prime movers may be described. By proper construction and observance of working conditions the centrifugal pressure, opposing the passage of the fluid, may, as already indicated, be made nearly equal to the pressure of supply when the machine is running idle. If the inlet section be large, small changes in the speed of revolution will produce great differences of flow which are further enhanced by the concomitant variations in the length of the spiral path. A self-regulating machine is thus obtained bearing a striking resemblance to a direct-current electric motor in this respect, that, with great differences of impressed pressure in a wide open channel, the flow of the fluid through the same is prevented by virtue of rotation. Since the centrifugal head increases as the square of the revolutions, or even more rapidly, and with modern high-grade steel great peripheral velocities are practicable, it is possible to attain that condition in a single-stage machine, more readily if the runner be of large diameter. Obviously this problem is facilitated by compounding. Now irrespective of its bearing on economy, this tendency which is, to a degree, common to motors of the above description, is of special advantage in the operation of large units, as it affords a safeguard against running away and destruction.

Besides these, such a prime mover pos-

sesses other advantages, both constructive and operative. It is simple, light and compact, subject to but little wear, cheap and exceptionally easy to manufacture as small clearances and accurate milling work are not essential to good performance. In operation it is reliable, there being no valves, sliding contacts or troublesome vanes. It is almost free of windage, largely independent of nozzle efficiency and suitable for high as well as for low fluid velocities and speeds of revolution. The principles of construction and operation are capable of embodiment in machines of the most widely different forms, and adapted for the greatest variety of purposes.

Progress in the Manufacture of Electrical Machinery and Apparatus.

A preliminary statement showing the general results of the thirteenth census of establishments engaged in 1909 in the manufacture of electrical machinery and apparatus was issued September 5 by Census Director E. Dana Durand. It presents a comparative summary of the statistics of the industry for the censuses of 1909, 1904, and 1899, and shows the number and value of the different kinds of electrical equipment manufactured during each census year. The report was prepared under the direction of William M. Steuart, chief statistician for manufactures. The figures are subject to such revision as may be necessary after further examination of the original reports.

The reports were taken for the calendar year ending December 31, 1909, wherever the system of bookkeeping permitted figures for that period to be secured, but in some instances where the business year of an establishment differed from the calendar year they relate to the business year falling most largely within 1909.

The electrical industries have had a most remarkable development during the past decade. The value of the machinery and apparatus manufactured for use in the generation and utilization of electricity increased from $105,832,000 in 1899 to $159,551,000 in 1904, and $243,967,000 in 1909, or 130 per cent during the decade. Large quantities of supplies used for electrical purposes are manufactured in foundry and machine shops and other establishments not identified with the electrical industries. These parts are assembled by dealers and others not covered by the census, and it is impossible to obtain accurate information in regard to them. Therefore, the totals given above are less than the true total value of all of the machinery of this character manufactured annually.

The value of products represents their selling value or price at the plants as actually turned out by the factories during the census year, and does not necessarily have any relation to the amount of sales for that year.

DYNAMOS.

Dynamos, dynamotors, motor-generators, and similar machines constitute the most important generic group of electrical machinery. The number of dynamos manufactured annually increased from 10,527 in 1899 to 15,080 in 1904, and 16,791 in 1909, an increase of 59 per cent for the decade. The value of the dynamos for each year was $10,473,000, $11,084,000, and $13,081,000, respectively. As a rule much larger and more powerful dynamos were manufactured in 1909 than for the prior years so that while the average value of machines manufactured was greater in 1909, they represented a lower cost for corresponding capacity. The average capacity per machine increased from 55 kilowatts in 1899 to 66 in 1904, and 84 in 1909. The value of the dynamotors, motor-generators, boosters, rotary converters, and double-current generators manufactured increased from $380,000 in 1899 to $3,155,000 in 1909, or 730 per cent.

The value of transformers manufactured increased from $2,963,000 in 1899 to $4,469,000 in 1904, or 51 per cent, and to $8,801,000 in 1909, or 197 per cent. The value of the switchboards, panel boards, cut-out cabinets for light and power increased from $1,847,000 in 1899 to $3,766,000 in 1904, or 104 per cent, and to $5,972,000 in 1909, or 223 per cent.

MOTORS.

The total value of motors of all kinds, including supplies and parts, manufactured increased from $19,505,000 in 1899 to $22,371,000 in 1904, and $32,087,000 in 1909, or 64 per cent for the decade.

The number of power motors manufactured annually increased from 35,604, valued at $7,551,000, in 1899, to 79,877, valued at $13,121,000 in 1904, and to 244,123, valued at $18,306,000 in 1909, there being an increase of 586 per cent in number and 142 per cent in value for the decade. Many powerful motors were manufactured, but the number of small motors has increased so rapidly that the average capacity per machine has declined, the average horsepower per motor for the three census years being 14.5, 8.5, and 6.7, respectively.

In 1899 there was great activity in the manufacture of motors for automobiles, but the increase in this branch of industry has not kept pace with that for other classes of electrical equipment. The number manufactured decreased from 3,017 in 1899 to 1,819 in 1904, with an increase to 2,796 in 1909. On the other hand, the capacity of motors reported increased 4,251 horsepower, or 52 per cent, during the decade, and the value of these motors has decreased from $192,000 in 1899 to $153,000 in 1904, but increased to $294,000 in 1909.

The number of small motors for the operation of fans has increased very rapidly. There were 97,577 such motors reported in 1899. In 1904 there were 102,535, and in 1909, 199,113, an increase of 104 per cent for the decade. The value of these motors increased from $1,055,000 in 1899 to $2,451,000 in 1909, or 132 per cent.

The statistics of motors for electric railroad cars can not be shown separately without disclosing the products of individual establishments, but there was a considerable increase in the manufacture of such motors as compared with the production of 1904, which was 12,298, of 713,181 horsepower, valued at $4,950,000. Considering the group of motors for cars, elevators and similar purposes, the combined number decreased from 23,582 in 1899 to 22,112 in 1904, and increased to 58,698 in 1909. The value of these motors was $10,707,000 in 1899, $7,929,000 in 1904, and $11,036,000 in 1909, there being an increase of 149 per cent in number and 3 per cent in value during the decade, the decrease shown for the group in 1904 being entirely due to the decrease in the manufacture of railway motors at that census.

BATTERIES.

The value of the storage and primary batteries manufactured increased from $3,679,000 in 1899 to $4,244,000 in 1904, and $10,612,000 in 1909, or 188 per cent during the decade. Both storage and primary batteries consist of various elements which are not always combined and sold together as a unit by the same manufacturers, and yet it is not until these are brought together that a complete cell is constituted. Many of the parts and supplies used are manufactured outside of the electrical field, and therefore the

statistics shown in this report do not convey a correct idea of the importance of this branch of the industry.

LAMPS AND FIXTURES.

The number of arc lamps manufactured increased from 158,187 in 1899 to 195,157 in 1904, and decreased to 123,543 in 1909. The decrease is accounted for by the fact that other varieties of lamps are now used for street light and for other purposes for which arc lamps were formerly used almost exclusively. The value of these lamps decreased slightly in 1904 ($1,574,000) as compared with 1899 ($1,828,000), but, owing to the introduction of more costly types of these lamps, such as flaming arcs, increased to $1,707,000 in 1909.

The group of incandescent lamps includes carbon, gem, tantalum, tungsten, glower, vacuum, vapor and similar lamps used for lighting, advertising and decorative purposes. Some of these varieties were not manufactured in 1899 or 1904. A large number of decorative and miniature lamps, X-ray bulbs, vacuum tubes, etc., are now manufactured, but the varieties are so numerous that it is impossible to obtain accurate statistics of the number. The total value of the group increased from $3,515,000 in 1899 to $6,953,000 in 1904 and $15,715,000 in 1909. The value of the carbon-filament lamps increased rapidly from 1899 to 1904, but there was a slight decrease in 1909, the value for the respective years being $3,442,000, $6,308,000, and $6,157,000. The manufacture of gem, tantalum tungsten and other metal-filament lamps was reported separately for the first time at the census of 1909, when they were valued at $7,682,000. Some of these new varieties of lamps were not reported separately at prior censuses, and it is possible that they were included with the carbon-filament lamps, thus accounting in part for the apparent decrease in that variety of lamp. Advertising, decorative, and all other lamps, including in 1909 glower lamps, vacuum and vapor lamps not separately reported in 1904, have increased in value from $645,000 in 1904 to $1,876,000 in 1909.

The total value of all lamps reported for 1909 was $15,715,000. This does not include sockets, receptacles, bases, etc., or lighting fixtures of any character.

The value of electric light fixtures of all kinds manufactured in 1899 was $3,751,000; in 1904, $3,295,000; and in 1909, $6,128,000. Large quantities of combination gas and electric fixtures are now manufactured. At the census of 1909 it was ascertained that the value of these combination fixtures was about $12,884,000. Their value for prior censuses can not be ascertained, and there were undoubtedly large quantities manufactured in connection with the manufacture of gas fixtures which are not identified with the manufacture of electric supplies, and their value is not included in this report.

TELEGRAPH AND TELEPHONE.

The telegraph instruments include intelligence (key, sounder, etc.) of all kinds, police, fire, district, and miscellaneous instruments, wireless apparatus, also switchboards and telegraph parts and supplies. The total of this group of instruments in 1899 amounted to $1,642,000, in 1904 to $1,111,000, and in 1909, $1,957,000, an increase of 19 per cent in the decade.

Telephone apparatus includes transmitters, receivers, complete sets of instruments (not included in the separate parts), interior telephone systems complete, and central switchboards, private exchange boards, parts and supplies. The total value of this group in 1899 was $10,512,000 as compared with $15,864,000 in 1904, and $15,547,000 in 1909, a slight decrease during the last five-year period.

The report also shows the value of the total annual output of miscellaneous apparatus used in connection with the utilization of electric current.

The accompanying table summarizes the statistics for the principal products as reported at the censuses of 1909, 1904, and 1899.

ELECTRICAL MACHINERY, APPARATUS AND SUPPLIES—PRODUCTS, BY KIND, QUANTITY, AND VALUE.

ITEMS.	1909.	1904.	1899.
Number of establishments	[1] 1,255	[1] 912	[1] 581
Total value of products	$243,967,000	$159,551,000	$105,832,000
Dynamos:			
Number	16,791	15,080	10,527
Total kilowatts	1,405,951	996,182	578,124
Value	$13,081,000	$11,084,000	$10,473,000
Dynamotors, motor-generators, boosters, rotary converters and double-current generators	$3,155,000	$1,740,000	$380,000
Transformers for light and power	$8,801,000	$4,469,000	$2,963,000
Switchboards, panel boards, cut-out cabinets for light and power	$5,972,000	$3,766,000	$1,847,000
Motors:			
For power—			
Number	244,123	79,877	35,604
Horsepower	1,623,677	678,910	515,705
Value	$18,306,000	$13,121,000	$7,551,000
For automobiles—			
Number	2,796	1,819	3,017
Horsepower	12,471	19,907	8,220
Value	$294,000	$153,000	$192,000
For fans—			
Number	199,113	102,535	97,577
Horsepower	178,033	30,796	12,766
Value	$2,451,000	$1,168,000	$1,055,000
For railways, elevators, and miscellaneous services, including supplies and parts—			
Number	58,698	22,112	23,582
Horsepower	859,237	763,399	684,791
Value	$11,036,000	$7,929,000	$10,707,000
Storage batteries, including parts and supplies:			
Weight of plates in pounds	23,119,331	16,113,073	[2]
Value	$4,678,000	$2,646,000	$2,560,000
Primary batteries including parts and supplies:			
Number	34,333,531	6,623,162	2,654,765
Value	$5,934,000	$1,598,000	$1,119,000
Arc lamps:			
Number	123,543	195,157	158,187
Value	$1,707,000	$1,574,000	$1,828,000
Searchlights, projectors, and focusing lamps	$936,000	$115,000	$226,000
Incandescent lamps:			
Carbon filament, gem, tantalum, tungsten lamps	$13,839,000	$6,308,000	$3,442,000
Decorative and miniature lamps, X-ray bulbs, vacuum tubes, etc. (also includes glower lamps and parts, and vacuum and vapor lamps)	$1,876,000	$645,000	$73,000
Sockets, receptacles, bases, etc.	$4,522,000	$2,011,000	$594,000
Electric lighting fixtures of all kinds	$6,128,000	$3,295,000	$3,751,000
Telegraph apparatus	$1,957,000	$1,111,000	$1,642,000
Telephone apparatus	$15,547,000	$15,864,000	$10,512,000
Insulated wires and cables	$50,338,000	$34,520,000	$21,292,000
Electric conduits	$5,098,000	$2,416,000	$1,066,000
Annunciators—domestic, hotel, and office	$236,000	$186,000	$225,000
Electric clocks and time mechanisms	$352,000	$374,000	$132,000
Fuses	$1,002,000	$868,000	$595,000
Lightning arresters	$940,000	$587,000	
Rheostats and resistances	$2,675,000	$933,000	$1,187,000
Heating, cooking, and welding apparatus	$1,003,000	$396,000	
Electric flatirons	$951,000	[2]	[2]
Electric measuring instruments	$7,800,000	$5,005,000	$1,842,000
Electrical therapeutic apparatus	$1,116,000	$1,037,000	[2]
Magneto-ignition apparatus, spark coils, etc.	$6,080,000	$678,000	[2]
Electric switches, signals, and attachments	$5,384,000	$1,451,000	$1,130,000
Circuit fittings of all kinds	$1,081,000	$3,525,000	[2]
All other products	$34,000,000	$26,179,000	$15,384,000
Amount received from custom work and repairing	$5,691,000	$2,799,000	$2,064,000

1 Includes establishments engaged primarily in the manufacture of products not identified with the electric industries, but incidentally making electrical machinery, apparatus, and supplies, as follows:

Year.	Number of establishments.	Value of product reported.
1909	246	$22,660,000
1904	128	18,742,000
1899	...	13,397,000

2 Not separately reported.

Electrical Notes From Great Britain.

By Our London Correspondent.

The great industrial and railway strikes extending from end to end of the United Kingdom, which are so serious from whatever point of view they may be regarded, will have been ended somehow by the time these lines appear in print. Although all departments of industry—including electrical and other engineering lines—have been held up to some extent, whether concerned in the quarrels or not, the disputes coming immediately within the scope of this journal are chiefly of a less serious description. As readers of these notes will have observed, there has been a growing agitation among employes of municipal electric tramway undertakings throughout the Kingdom. It is an important aspect of municipal operation that cannot be ignored, that large bodies of tramway operators find it more profitable to urge their claims where councillors are supposed to be their masters, and where profits are supposed to belong to the taxpayers, than where they are employed by companies. The first tramway trouble of this past month broke out at Leeds and the men went back to work very quickly, having received a measure of satisfaction. Not many days thereafter, and while dockers and carmen were pressing their claims in London and elsewhere, the tramway men of Glasgow and those of London sought to bring about for better conditions. At Glasgow the Corporation Tramway Committee wisely left the settlement in the hands of the manager, Wm. Dalrymple. Many cars were smashed in the disturbances that ensued, but a partial service was maintained, and in a very short space of time the whole strike was at an end. The strikers all returned to work with the exception of some fifty or sixty and these handed in their uniforms. The loss of revenue amounted to about $30,000 and the damage to the rolling stock was considerable.

In London a strike has not yet broken out. The men here are aggrieved because the Conciliation Board established to consider grievances as they arose did not work speedily enough for them, nor did its decisions always end as they desired. They have formulated their claims, two only of which would cost the taxpayers more than $500,000 per annum to satisfy, though the profit on working the system is ridiculously small for an undertaking of such proportions. They threaten to strike unless the Conciliation Board acts at once, but it is vacation time just now and the Board will not meet in the ordinary course for a month or two. Meetings are now taking place nightly and a ballot may be taken which, if it ends in a strike, will deprive the public of a service upon which they are more dependant than ever now that the railways are disorganized. At Liverpool where the ferment is worse than anywhere else the tramwaymen have resisted temptations to strike but on the night of August 17, the cars were brought to a standstill because of a strike among employes at the big electric power station in Lisber Drive. The electric light and power supply to industrial works and private residences were also interfered with.

At Manchester the tramwaymen resisted all persuasion to come out. Soldiers were on guard preventing interference with the working of the Great Eastern Railway power station at Stratford, London, on August 18, and on the same morning the subways which had been looked upon as certain to continue running, were disorganized first by the elevator men coming out on strike and later by a curtailment of service owing to the fact that the train staff received orders to cease work. Five hundred men employed by the Western Electric Company, Limited, at Woolwich, were among the strikers, but their differences were soon satisfactorily settled and work was resumed. Some of the post office telephone workers who had already placed their demands before the Postmaster General, urged their claims afresh — indeed everybody who considered he had a grievance seemed to hit upon the middle of August as the most likely time for securing its redress.

On September 23 the Electrical Exhibition organized by the National Electrical Manufacturers' Association will be opened at Olympia, London. The last big show of the kind held in London was in 1905. Three years later the Manchester district was favored. If one can read the present signs correctly this year's exhibition will be a still greater success than either of these. All the floor space and most of the gallery have been taken and if the event receives suitable prominence in advertising the occasion should be the finest we have had in England for an up-to-date publicity and development effort among the people. The Joint Publicity Committee of the metropolitan electric supply systems (companies and municipalities) have taken space valued at $5,000 and, if the attendance is as good as is expected, there will be a month of live publicity activity on the part of those attending. A very prominent feature of the exhibition will be an elaborate display of cooking and heating apparatus in the gallery. Manufacturers in return for giving demonstrations here, have had space and energy granted to them free of charge. There will be a model electric home, and it will have a garage, an electric laundry, electrically equipped kitchens, and many other features which experience has shown are popular means of familarizing the public with the applications and advantages of electricity in the up-to-date home.

The British Association for the Advancement of Science opens its meeting at Portsmouth on August 30. The program for the Engineering Section includes a number of subjects of electrical and allied interest as follows: "Electrical Drives for Ships' Propellers," by H. A. Mavor; "Electrical Steering," by B. P. H. Haigh; "Recent Developments in Radio-telegraphy," by Prof. G. W. O. Howe; "Suction Gas Engines and Producers," by W. A. Tookey; "Smoke Abatement," by Dr. J. S. Owens; "Economical and Reliable Power Generation by Overtype Superheated Steam Engines," by T. Marshall; "A Friction Permeameter," by W. H. Murdoch; "The Electrical Conductivity of Light Aluminum Alloys," by Prof. Ernest Wilson; "Corrugation of Tramway Rails," By W. Worby Beaumont; the "Vibragraph," by W. P. Digby, etc. The presidential address will be delivered by Sir William Ramsay.

I recently gave particulars concerning the working of the Glasgow Corporation tramways during the last completed fi-

nancial year. The Municipal Electricity Supply Department has now issued its report which contains interesting results. There were sold to all classes of consumers 39,063,540 kilowatt-hours, so that compared with 34,742,853 units in the previous year, the increase is 12.44 per cent. Lighting consumers required 15,253,601 units, power and heating 23,809,939. The heating alone was for 583 consumers who used 286,076 units; power users numbered 2,936. Nine million units produced 1.5 cents per unit, and seven millions only one cent. The total consumers numbered 21,166, an increase of 1,677 or 8.60 per cent. Of motors on circuit there are 5,375 aggregating 36,831 horsepower. Street lighting is being improved, and a number of ordinary lamps are being replaced with 200 flame-arc lamps of much higher candlepower. In the several generating stations full use has been made of recording water-meters and other apparatus with a view to insuring efficient and economical combustion of fuel, and the fuel account amply justifies the purchase of this apparatus. The previous year's figure for coal consumption per unit generated (4.151 pounds) has been this year reduced to 3.4704 pounds, equivalent to a saving of 14,910 tons of coal. In October last a scheme was introduced whereunder domestic consumers obtained a supply of energy for cooking, heating and other domestic uses at two cents per unit as compared with 2.5 cents per unit for lighting, without separate wiring. By May last (the end of the financial year) 300 consumers were already benefiting by the scheme. As the existing generating stations are filled to their utmost capacity, a new station for which a site has already been secured, will be built. The financial results of working the undertaking showed a gratifying improvement. Briefly stated they were as follows:

The gross revenue was $1,302,630; working expenditure $547,734; interest and sinking fund $498,733, leaving a balance of $256,164. Out of this $222,760 has been applied as depreciation written off capital account, which together with sinking fund contribution, is equal to a rate of four per cent upon the gross capital expenditure. There remains a surplus on the year's operations of 33,400, as compared with only $954 in the previous year. The surplus has been applied to reserve. The revenue increased by $72,830, while the working expenses were only $20,544 more, though nearly 6,000,000 additional units were generated. The average cost per unit has been reduced from 2.6618 cents to 2.4608 cents, a decrease of 2.010 cents.

Crompton & Company, Ltd., one of our oldest electric manufacturing companies, reports a loss of $70,000 for the past year, as compared with $140,000 in the previous year. John Trotter, the chairman, in referring to the state of the electrical industry, said that prices had remained low, and it required a large turnover to make a satisfactory profit. The condition of electrical manufacturing made it far from easy to obtain large sales, but there was now a very distinct improvement. Their present policy was to fill the works with business but to steer clear of business likely to unduly lock up money. This involved the rejection of a certain amount of contract work. In the interests of economical working the company's general manager had resigned, and Colonel Crompton had relinquished his fee as technical adviser. Colonel Crompton who addressed stockholders at a later stage of the annual meeting said it was quite untrue to say that they could not manufacture at present prices and realize a large profit on orders. The substance of the whole difficulty was the present lock-up of capital, and if they could surmount that difficulty they could earn sufficient to pay a good dividend.

The Holborn (London) street lighting contract, about which there has been such a prolonged controversy in the Holborn Council, and between advocates of electricity and gas, has at last been settled. To this end a joint tender of the Gas Light & Coke Company and the Metropolitan Electric Supply Company, for lighting the streets of the borough, has been accepted for ten years at $38,225 per annum.

The Yorkshire Electric Power Company reports for the past six months an increase in supply of electricity to local authorities and others holding electric lighting powers "as showing a growing appreciation of the advantage of purchasing in bulk from the power company in preference to generating at their own stations."

ALBERT H. BRIDGE.

London, August, 1911.

Electric Fan for a Queen.

The General Electric Company has just finished an electric fan for Queen Mary of England. It will be used to dry her hair after a shampoo. The fan is mounted in gold and has an ebony switch. It was specially designed to be in keeping with the royal toilet articles.

Cannot Force Utility to Operate at Loss.

According to a court decision the New Sharon (Ia.) Public Utilities Company cannot be forced to run its plant at a loss. The city contract with the electric light company was canceled but the town authorities demanded that the plant continue to operate despite the contention of the company that its operation would be unprofitable. The town authorities then went into court and asked that a receiver be appointed for the company.

The court in its decision held that the town had no right to ask for a receivership inasmuch as it was not a stockholder of the company and that it could not compel the utility to operate its plant at a loss.

Electrical Activities in Japan.

A report on electrical industries in Japan, prepared for the London Board of Trade, shows a boom in electrical activity in Japan. The number of new proposals for undertakings and extensions of existing ones has increased during 1910. In August a light-railway law was put in force. The object of this law is to enforce proper control over the promotion of schemes for constructing light railways, and also to encourage the construction of such lines in order to connect minor centers of trade and production with the existing lines of railway. The nationalization of the railways has had the effect of checking private enterprise in this direction, while the State is unable to spare funds sufficient to meet the demands for railway extension. Consequently it is hoped that this law will attract private capital to the construction of light railways.

Most of the light railways use electricity as their motive power and also undertake the supply of electric light. During the year a number of orders have been received for the erection of small plants for the supply of electric light, the power being generated by gas engines. In the industrial cities of Osaka and Tokio a large and growing demand exists for gas motors for use in small factories.

Electrical Notes from Continental Europe.

By Our Paris Correspondent.

An extensive piece of electric tramway work has been the change-over of the Lyons suburban lines from the direct-current to the single-phase system. The City Tramway Company, which owns the lines, found that it would be a disadvantage to continue working with direct current owing to the extension of the lines which was needed, as the feeders on the old system were already quite expensive. Owing to the good results obtained by the Westinghouse single-phase system, the company decided to adopt it for the new lines and to change over the old ones at the same time. All the suburban lines run into the center of town, but the regulations forbid the use of high-tension within the city limits and at the same time the city lines are already equipped for direct current, so that the new cars are obliged to work on single-phase current at 6,600 volts and direct current at 600 volts.

The first two lines, one from Mirbel to Montlull of twelve miles length and a second, the Jons line, having now thirteen miles but which will be extended to thirty-five miles, have now been finished. The lines are standard gauge and have the trolley wire supported on the catenary system from bracket poles. A substation on the line receives current from the Montiers hydraulic plant and this is transformed to 6,000 volts, fifteen cycles, by a motor-generator. At the city limits is a twenty-five-foot section which carries no current, in order to change over from single-phase to direct current. This latter is supplied by the city feeders. On the cars is mounted a pantagraph trolley for the suburban lines and two ordinary trolleys for use within town. The car motors are designed to work either at 300 volts, fifteen cycles, single phase or 275 volts direct current. Two forty-five-horsepower motors are used here, and they are connected in series for direct current and in parallel for alternating current. In the latter case a transformer is used and this is of the sixty-kilowatt oil type. One end is connected to the 6,000-volt line and the other to the ground, as an autotransformer with single coil is here used. Various taps allow of taking off 100 to 315 volts for purposes of control. The controller used has three drums, one each for direct and alternating current, and a third for reversing upon either kind of current. The present lines have been in operation for some time past and work very satisfactorily. The outfit of the lines comes entirely from the Havre works of the Westinghouse Company.

In connection with the Paris University there is soon to be built a Radium Institute which will be presided over by Mme. Curie and will be the center of researches to be made in this field. It is to have many unique features, and one of the most striking is that all the inside walls will be lined with a heavy lead covering, seeing that lead is one of the few bodies which cut off the rays of radium. The foundations of the building are to be laid according to special designs and using very solid materials, and will run down for quite a distance in the ground. This is done in order to carry the great extra weight which comes on them from the lead lining.

What M. Dussand calls "cold light" has been attracting some attention in Paris since it was brought out before the Societé de Physique and other bodies. This, however, is simply an ingenious method of working a tungsten lamp at over-voltage and as the lamp must be sacrificed the method cannot be applied in a commercial sense. It is, however very well adapted for use in projection lanterns where a bright light is needed for an hour or more, and after this time the lamp which is a small one, can be renewed without much cost. Seeing that the tungsten lamp filament changes its temperature very quickly with the current, a high over-voltage can be applied at short intervals by using a revolving-contact device, and an economy of current is thus obtained. Owing to the quick change of temperature, the lamp is only lighted while the current is on and the filament is dark in the intervals, but the eye sees no difference owing to the fact that the light impression is continuous. The proof which would seem to be required for this rapid rise and fall in the light of the filament is given by the fact that such a lamp can be used behind a moving picture film without needing a shutter such as is required otherwise, seeing that the successive change of the film views occurs during the dark intervals of the lamp. The writer had occasion to observe this action at the Ducsetet establishment, and the moving pictures appear on the screen in the usual way, showing that the light of the filament actually varied. It follows that the heat given out by the lamp is much less than usual.

A process for electro-plating upon porcelain has been applied very successfully in Germany and is now being operated on a commercial basis by the electro-porcelain works of Berlin, employing the Gerbing patents. It is stated that the porcelain or similar body is given a conducting coat of graphite dissolved or suspended colloidally in a solution of an alkaline silicate. The metal coating obtained by the process is very solid, and a number of practical uses can be found for it. The manufacturing firm has already placed on the market a number of porcelain articles coated with silver or nickel.

Current is now supplied very extensively for operations in the Baku oil region, and steam is being superseded for use in the wells. Two large electric plants are in operation at present for producing current throughout a wide district, these being the Bailor and the Beligorod plants. Where steam was used for the machines at the wells, the boilers were fired with crude oil, but it is found that electric motors are more economical owing to various expenses which come from the use of steam. An electric project of considerable scope is on foot in the Causasus region, centering at Tiflis. A foreign syndicate has applied to the Turkish Government for the franchise needed for erecting two electric stations of large size and these are to be used for supplying current to the mines and other industries throughout the country and also for operating an electric railroad which is proposed to build from Tiflis to Vladicaucasus. At the same time there will be opened up large copper mines in the region, and these will serve to supply the copper which is needed for the electrical work.

Captain Brenot is carrying on some experiments with wireless apparatus on aeroplanes and has been very successful in his recent trials with an aeroplane fitted out with a 400-foot hanging wire and a complete set of apparatus. Owing to the weight of the bracing frames for the apparatus, the weight was brought up from twenty-four to fifty-five pounds. The fifty-horsepower motor of the aeroplane gives the current. On a recent occasion Captain Brenot and Lieutenant Menard sailed at a height of 1600 feet in the region beyond Versailles, and when at thirty-seven miles from the Eiffel Tower they could still send messages to that station. Owing to a leak in the insulation, the spark they employed was only one-fourth of the standard, so that it is very likely that a distance of 150 miles and over can be covered with the present outfit.

The Public Works Department of France is taking steps to erect a number of wireless posts on the Atlantic and the English Channel in order to protect vessels during fogs. Although the idea was brought out as long ago as 1900, at the International Navigation Congress held at Paris, it has not been realized as yet owing to numerous difficulties which lie in the way, these coming from a lack of means of locating the posts and also the interference of these signals with commercial messages. However, the recent experiments made with the Bellini-Tosi directed-wave system on board the ocean liner *Provence*, whose outfit we recently described, and since then on the French battleship *Carnot*, appear to have solved the problem, so that the Government has now decided to erect the shore posts at once, on account of the great benefit which these will give to navigation. Three posts will be erected according to the present plans, and one of them will be located at Havre. It is intended to use a high-pitch musical vibration of 500 to 700 periods per second, and a signal consisting of a letter representing the post in question will be repeated for ten seconds at a time. Each station will produce a definite musical note.

The city and suburban tramway lines of Parma are now being operated by the Siemens-Schuckert single-phase system, using 4,000 volts in the suburbs and 400 volts inside of town. Alternating current is used on the city section as well. The lines include two long sections running to Marzolara and Tornovo, of about fifteen miles length each. Two central stations supply the current at 4,000 volts, and this is reduced for the city lines to 400 volts within the station itself and also in three substations. A transformer is carried on the car so as to allow of running the motors at different voltages.

Following the practice which prevails in England and Belgium, Paris is to have a central telegraph exchange board, somewhat on the idea of the telephone exchange. This is needed in order to put the various towns lying near the city into direct communication as at present the practice is to receive the messages at Paris and then retransmit them. About 140,000 transmissions of all kinds per day are made in the central office, and nearly 60,000 of these are re-transmissions to towns which in fact lie near together. When the exchange board is installed, such towns will be directly connected, and this will take much work off the central telegraph office and the messages will be received much quicker.

An "electric hotel" is to be erected at Paris at a cost of several millions, following out the ideas which were already so successful in the Electric House now installed there. This latter has been designed by a prominent engineer, G. Knap, and consists of a building in which everything is done by ingenious electrical devices. The automatic dining table is served entirely from the basement by motor-operated devices, using a telephone and a periscope concealed in the chandelier. The present idea is to be much extended in the new hotel, and domestics will be almost entirely absent. M. Knap has already formed a syndicate for the purpose of building the electric hotel. All the rooms will be served by automatic apparatus communicating with the basement, and in addition to the former ones, many new devices have been patented for the purpose.

A. De Courcey.

Paris, August 24, 1911.

Hydroelectric Development on the Deerfield River in Vermont and Massachusetts.

Details of the project for the hydroelectric development of the Deerfield River, promoted by interests connected with the Connecticut River Power Company, were announced in Boston recently when the completion of an underwriting agreement for the issuance of $3,000,000 five-per cent forty-year gold bonds and $750,000 six-per-cent cumulative preferred stock became known. The New England Water Power Company has made an underwriting agreement with a banking syndicate headed by Baker, Ayling & Company of Boston, in pursuance of which the bonds and stock will be issued. The work has been planned by Arnold B. Chace, Jr., of Providence, and Henry I. Harriman of Boston.

While engineering estimates show that this financing should provide generating plant and transmission lines for some 25,000 horsepower, it is likely to be only a step in the eventual development of Deerfield River water-power rights now controlled by the same interests. Such developments, however, doubtless will be spread over future years, and it is figured that it will entail total expenditures of between $12,000,000 and $14,000,000.

The Connecticut River Power Company has already sold practically its entire output and an immediate market is assured for the Deerfield River power to be made available by the pending financing. It is planned to connect the Deerfield River lines with those of the Connecticut River Power Company.

Initial construction will result in damming the Deerfield River in four places near Shelburne Falls, as well as the creation of a reservoir at Somerset, where water will be impounded to a height of 100 feet and over an area of approximately six square miles.

The ultimate development of power will be to a large extent in Vermont, the financial interests already owning the power sites and flowage rights necessary. Work will be commenced shortly both in Vermont and Massachusetts. The legislature of 1908 granted a charter for the Vermont development under the name of the Wilmington Power & Paper Company with the right to change the name of the corporation as the stockholders might desire. The name will be changed to the New England Power Company of Vermont. There will be also the New England Power Company of Massachusetts which will be owned by the same interests. Development will be carried on together. The storage development in Vermont will, of course, be for the benefit of both the Vermont developments and power and the Massachusetts developments.

Central-Station Practice

ALUMINUM VERSUS COPPER IN ELECTRIC POWER TRANSMISSION.

EUROPEAN EXPERIENCE.

BY C. H. PALMER.

The substitution of aluminum for copper for overhead electric power transmission has given excellent results with a very considerable saving and consequently quite a number of lines with aluminum conductors are now at work in Europe, many of them in Great Britain. There is a 3,000-volt line transmitting 1,000 horsepower to collieries on the northeast coast; this was constructed at the low cost of $2,400 per mile. A 3,000-volt line was erected by the English military authorities. There is also a 600-volt line supplying collieries in South Wales. Many experts have questioned the durability of aluminum, but so far as experience goes it may be said to be as good as copper, as the hard oxide skin naturally formed on the aluminum wire protects it against further corrosion. The precise origin of a considerable number of disturbances and interruptions are recorded, but none are known in which difficulties have been caused by the use of aluminum instead of copper. The economy of original outlay by substituting aluminum for overhead lines is undeniable, and it is not neutralized by any appreciable increase in the cost of the poles or of erection, and experience has shown that no unexpected troubles due to corrosion need be feared.

European experience of the economy resulting from the use of aluminum may be summarized as follows: A hard-drawn aluminum wire has sixty-one per cent of the conductivity of a hard-drawn copper wire of the same size, therefore the former must have 1.64 times the sectional area and consequently 1.28 times the diameter of the equivalent copper wire. As the specific gravity of aluminum wire is only 2.71 compared with 8.95 for copper wire, the former will weigh slightly less than half the equivalent copper wire or cable.

Aluminum at the present time is quoted at $312 per ton and copper at $281; the expenses for drawing into wire are of course larger per ton for aluminum than for copper and the cost of hard-drawn wire may be taken as $432 per ton for the former as against $328 for the latter. On the basis of these prices it will be found that any aluminum cable will cost only sixty-four per cent of the equivalent copper cable so that a saving of thirty-six per cent on the cost of the cable can be effected by the substitution of aluminum for copper. The value of aluminum per ton is a tolerably steady one, the quotations for copper fluctuate within very wide limits. The value given above, $281, is a particularly low one and if for example an average figure of $312 per ton be taken (corresponding to about $360 per ton for hard-drawn wire) a saving of forty-one per cent on the cost of a cable would be effected by the substitution of aluminum for copper.

In a transmission line the cost of the actual copper conductors may be assumed to range from fifty to seventy per cent of the total cost of the whole line, including poles, insulators and so on, according to the electrical pressure and capacity of the line and the circumstances in which it is erected. The percentage is the larger the lower the pressure and the greater the capacity. It follows that by the use of aluminum a clear saving of from eighteen to twenty-five per cent on the total cost of a transmission line can be obained even with copper at the moderate figure of $281 per ton.

It is, of course, assumed that the cost of the pole line itself, exclusive of the conductors, will be the same whether copper or aluminum cable be employed; for while the lighter weight of aluminum conductors is an important advantage from many points of view, the effects of the greater surface offered to the wind and the lower tensile strength are such that the poles for an aluminum line constructed according to public requirements in England have to be almost as strong as and slightly higher than those for an equivalent copper line. Consequently British engineers erecting transmission lines to withstand severe conditions of wind pressure, do not reckon upon any great saving in the cost of the poles by using aluminum.

The difficulties formerly encountered in obtaining a satisfactory joint have been quite overcome by the use of the twisted sleeve joint; whilst troubles due to corrosion from galvanic action have been eliminated by using tie wires, binding wires, clamps, and so on, of aluminum and thoroughly protecting from moisture any part where aluminum is in contact with another metal. The ultimate stress of hard-drawn copper wire may be taken as 54,000 pounds per square inch and that of aluminum as 27,000 pounds per square inch, practically half. While higher values are obtained for wires of small diameter of both metals, it is found that cables stranded from such wire give somewhat lower results and the above may be accepted as average values. It is usual to erect lines with a sag or pull on the wire, such that on the temperature falling to a certain minimum and the wind pressure rising to a certain maximum velocity (say thirty pounds per square foot) the tension in the wire shall not exceed a certain limit, say one-fifth of the breaking stress (in France one-third). The calculated strain should be made under the assumed worst conditions of a very low temperature, a high wind and a liberal allowance for snow or sleet all occurring at the same time.

Allowance should also be made for the elastic limit of the wire, for should it be subjected to a greater strain than that limit, it immediately stretches permanently and though the strain is relieved, it becomes a thinner and weaker wire of greater electrical resistance. The elastic limits of both copper and aluminum are about sixty per cent of their breaking stresses and it would appear advisable, from whatever basis the factor of safety is considered, to allow a permissible maximum stress in the aluminum cable of half that in the copper cable. As the aluminum cable has a sixty-four per cent larger section, the actual pull along the cable under the

worst conditions will be only eighty-two per cent of the pull along the equivalent copper cable, and if, as is often the case, the poles or trolley are designed to withstand the unbalanced pull of all the cables on one side, those for the aluminum line will be required to withstand only eighty-two per cent of the pull which those for an equivalent copper line will have to bear.

It should be remembered that the diameter of the aluminum wire is twenty-eight per cent greater and that the tension due to the maximum wind pressure is very much greater than that due to the weight of the cable, especially for cables of small size. As a result of this extra tension due to wind pressure, as compared with a copper cable, the vertical sag of an aluminum cable must for the same factor of safety under the worst conditions be some thirty per cent greater than the sag of the corresponding copper cable, even taking into account the greater elasticity of aluminum. This is due to the fact that the stress per square inch resulting from the weight alone has to be kept very low in order to leave a sufficient margin for the greater stress due to wind pressure. Further as the co-efficient of linear expansion with temperature is greater in the case of aluminum, the increase in the sag in hot weather is slightly greater for aluminum cables than for copper cables. For these reasons the point of suspension must be somewhat higher in the case of aluminum cables, if the same minimum height of the cable above ground is to be secured. This increase in the height of the poles largely counterbalances the effect of the smaller strength required, with the result that the poles for an aluminum line cost nearly as much as those for an equivalent copper line.

Perth Amboy Plant Completed.

The Public Service Corporation has completed its new power station at Perth Amboy, N. J. The building is located at the foot of Buckingham Avenue and is of steel, brick and concrete construction. It presents a very attractive aspect when viewed from Staten Island Sound. The initial installation includes two turbo-generators, each of 4,500 kilowatt rating.

Smoke Abatement Exhibition at Manchester.

It is announced that a Smoke Abatement Exhibition will be held at Manchester, England, from November 10 to 25. The electricity department of the municipal corporation is actively in charge of the exhibition. A particular feature of the exhibition will be a very complete display of electric heating and cooking appliances.

Commercial Practice—Management, Rates, New Business.

A Portable Electric House.

The electrically equipped kitchen noted in Fig. 1 and the dining room and library seen in Figs. 2 and 3 show the electric equipment of three rooms of a five-room portable "Electric House" erected in Newton Center by the Edison Electric Illuminating Company of Boston. This electric house is chimneyless and represents the height of electric development in domestic life.

It may be stated that from the door bell, which rings by current from the lighting mains, through the hall and the living room, with its comforts for happy evenings after busy business days, to the dining room with its economical luxuries, electric switches are within the reach of everyone in the home.

It is of interest to note that the sleeping chambers are models of comfort and attractiveness, and the kitchen, with its complete electrical equipment, the pantry, with its plate warmers and other practical conveniences, and the laundry, with electric washing machine and conveniences for electric ironing, make house-keeping a pleasure.

In the garage is an electric vehicle and many electrical conveniences so necessary to the autoist's use, the whole equipment being a marvel of complete and efficient economy. At the front of this electric house is a pergola 8 feet by 10 feet, while the major portion of the house is 34 feet square, providing five spacious rooms each 14 feet square. In addition to the rooms already mentioned there is a reception room in the center of the cottage which makes a fitting entrance for the many guests who are welcomed there.

This electric house is a portable building built in Dover and transported from the factory on electric trucks to the place of its first location in Winchester. The electric wiring was installed in the sections of this house as it was being put together, so that when the house was moved a few weeks ago from Winchester to Newton the transfer was made easily and quickly.

After the house was assembled it was completely furnished with handsome and luxurious furniture in keeping with the surroundings. The excellent taste that has been shown in selecting the furnishings would make this residence a most attractive place, even if there were not the additional features of the electric service.

FIG. 1.—KITCHEN.

In the dressing room or chamber an electric curling-iron heater may be always available for the comfort and convenience of the hostess or her guests. There is wonderful comfort, safety and convenience in the electric heating pad as it never leaks, will maintain a constant temperature and can be kept at the head of the bed, available for any emergency. A sudden attack of neuralgia, or any illness, even "cold feet," can be corrected promptly and effectively by simply putting the heating pad against the spot where it will do the most good and turning on the current. This electric house is provided with many other electric devices and their combined comforts will make the home happy.

FIG. 2.—DINING ROOM.

FIG. 3.—LIBRARY.

Street-Car Advertising in Boulder.

The Northern Colorado Power Company, which supplies electric current to a number of towns in the northern portion of the state, is making use of the street cars for advertising in its campaign to increase the use of current-consuming devices. In the city of Boulder, a piece of canvas is stretched on the side of the car, and bears the inscription

FREE TRIAL
ELECTRIC IRON.
PHONE BOULDER 32.

It is realized that if customers can be induced to try an electric iron once, a large proportion of them are certain to remain permanent users.

New Australian Submarine Cable.

The Pacific Cable Board has been authorized to lay an additional submarine telegraph cable between Australia and New Zealand.

ELECTRICALLY ILLUMINATED SIGN ADVERTISING.[1]

BY L. D. GIBBS.

We all know that volumes have been written—no matter whether we have read them or not—on the subject of advertising. Enough papers have been read to make several volumes. And every man who has written has shown his true modesty with an apologetic remark to the effect that he really did not believe he had anything new to offer. Nevertheless, we all straightway proceed to offer something.

One reason why there have been such rapid strides in advertising is that every advertising man is a crank on at least one phase of the business. Most of us are mild-mannered, harmless cranks, but the very fact that on some line we think our way is the best makes us ready to stick up for and defend our ideas. When we begin to defend we dig up the points from all sides and we are bound to improve our methods, we are certain to increase our own knowledge of the subject and the result is steady growth, for I know that, cranks though we may be, we want to improve our own work as well as that of our associates.

Electric sign advertising, of course, includes a marvelously wide field of activity. We can scarcely realize that what we now regard as feeble and ineffectual attempts to catch the eye with the little incandescent lamp were once samples of marvelous advancement in electric business-getting. It makes us pause when we think of the point of view of the little boy in the story. He was taken along busy Broadway to see the signs and bright lights, but he made no comment until he reached one of the cross-town car lines where he waited several minutes to look at the novelty of a horse-drawn street car. For that twelve-year-old boy our commonplaces of yesterday were the novelties of today.

The great contrasts in the development of electric sign advertising may be noted by a trip through the side streets or the slums of our larger cities. We step from the brilliantly lighted thoroughfares with their tremendous signs, where floods of light roll along the streets into the regions where little signs cast a feeble light and a few panes of colored glass make almost hopeless attempts to attract attention.

I think we are quite likely to narrow the field of advertising by electric lights, to signs with reading on them or with some peculiar flashing designs, but as a matter of fact everywhere a light glows we can find a call. The little light that burns over the doctor's or the undertaker's doorbell, the red lights burning in the theaters or the convention halls over the word "Exit" and some other lights—in drug stores, in front of police stations, over fire alarm boxes and elsewhere all carry a message. The little hash-house on a side street may have its sign "Cafe" or "Lunch," or even may rise to the dignity of "Restaurant," but it is calling for business in its feeble way.

The field is so large that it is wandered into from every side with varying successes. There are small transparencies for the small stores, cheap signs illuminated by the reflected light of one lamp for the small advertiser

1 Abstract of a paper read before the Boston Meeing of the Outdoor Advertising Section of the Associated Advertising Clubs of America.

who may, however, get into the national field some day; and there are the galloping horses, the foaming beer steins, the billiard games in operation and so on up through the scales of size and cost to dizzy combinations of color and design.

I have no actual figures upon which to base my deductions; I have not been able to check my theories with so-called "results," but I believe that at least one form of advertising value of electric signs increases in geometrical progression as the cost of constructing the sign increases; that is power to attract attention. That means that a sign costing $10 may be expected to attract the attention of 40 people in a given time, while one costing $100 may be expected to attract the attention of 1,600 people. This assumption, of course, is made with the understanding that both signs are displayed in localities frequented by a sufficient number of people to make the comparison a fair one.

This does not mean, however, that the forty people in one case and the 1,600 in the other are attracted with sufficient power to bring sales, but is simply my idea of what such signs can do in catching the eye. A man may easily be attracted by the light or the design of a sign and not carry the impression away with him of what the sign is for.

I do not believe that a sign costing $10 put in a locality that is large enough to make a $100 sign effective will have much, if any, commercial influence. It might possibly attract the commercialized attention of one person. The $100 sign, however, may be reasonably expected to exert a commercialized influence over at least ten people.

Above these costs I believe the proportion of attention-compelling influence will increase in much greater proportion to the outlay. Above the $100 figure I believe the advertiser gets the value of increased dignity of construction and design. He gets more pronounced detail; he gets better color schemes and more of them, and such signs are consequently more attention-compelling.

Another important point with the more expensive signs; they surround the commodity advertised with a certain dignity; they give the product "class." Expensive construction for signs to advertise cheap products is by no means a poor investment. Several kinds (of what are claimed to be excellent brands) of beer and other liquid refreshments sell over the bar at very low prices, but hundreds of thousands of dollars are spent in the construction of remarkably attractive signs to advertise the delights of these beverages. A consumer likes to know that the things he eats, drinks and uses are dignified with big places in the advertising world.

Some kinds of display advertising are distinctly connected with particular commodities and lines of commercial activity. No man need look a second time at the four-armed contrivance revolving red, white, blue and green incandescent lamps before his face. It is in an optical shop, and ten to one it is a cheap shop at that. The sign with the so-called rat running around the edge, nine times out of ten calls attention to a second-hand clothing store, a ticket scalper's office, a small theatre or some cheap brokerage establishment.

I am somewhat surprised that the pawnshops have not yet awakened to the fact that they could hollow the wooden "gold" out of their three-ball signs and make them lustriously incandescent at night by inserting incandescent lamps.

To my mind the bigger the sign, if it holds to lines of dignity, the bigger must be not only its attention-compelling capacity but its selling capacity. The trouble with so many of our great signs today is they are too intricate; the designers have lost sight of the fact that to enable the mind to receive any lasting impression the object viewed must remain quiet for a second or two at least.

This is the one criticism that may be made of several of the biggest and most fanciful signs in the country today. The observer is grabbed and carried along by the sense of restlessness, the hurried rush and tear of the whole display; his powers of observation, and, consequently, his mental impressions are impelled to such a pace that when the reading or selling talk comes on he jumps it practically without thought. We must at no time forget that the simplest things are usually the most forceful and likely to make the most lasting impression.

The ordinary bill-board sign, equipped with a single inexpensive hood reflector properly arranged to give complete illumination over the reading surface, has an attention-compelling and a commercializing value far in excess of the expectations of most people. Its value in all ways is certainly far and away greater in proportion to the outlay than can be claimed for great numbers of our so-called unique flashers. It has a two-fold advantage of being able to do full duty during daylight hours and then with the light reflecting upon it it has remarkable attracting power during the night hours.

It would seem as though illuminated signs of this kind read easily in the daytime, and even more readily at night, would be utilized much more by national advertisers. Of course the public lighting companies are glad to have the business that comes to them in the operation and lighting of the big novelty sign. They would be equally ready, however, to further the development of the ordinary illuminated bill-board sign business. It is a simple way of reaching the public at a time when they least expect it.

The illuminated board signs of Boston are excellent commercializers. Experts in other lines of advertising take their prospects to study the crowds and see how particular lines of advertising attract. It is only necessary, if you choose to investigate the subject, for you to watch people passing along a thoroughfare that has illuminated bill-board signs. I have seen people absorbed in books and newspapers turn to look at lighted bill-board signs and they had the pleasure of seeing all there was to be seen of them in a brief glance.

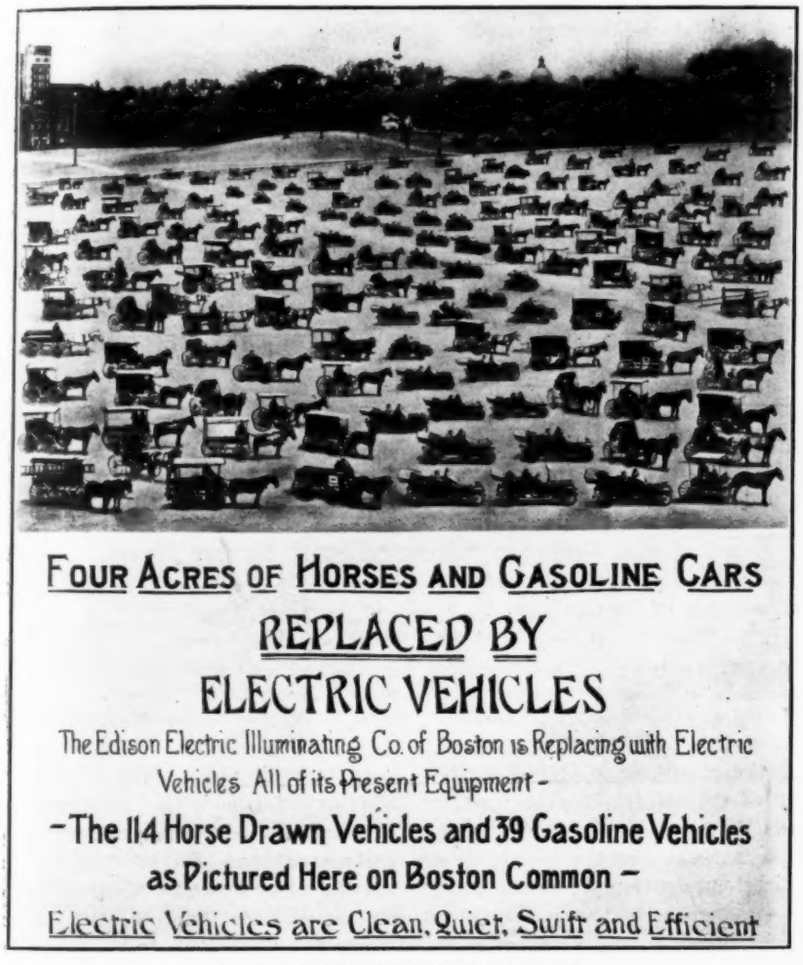
The trouble with many of our flashing signs is that they take too long to tell their story and paradoxical as it may seem they tell it too quickly.

Few people realize today what the illuminated sign advertising business has done to brighten our streets and turn our city nights into day. Everywhere one turns are the lights—in windows, over doors, in the street lamps, in the signs extending over the sidewalks and in the great signs projecting above the buildings into the heavens from the horizon of night.

All these developments of our advertising ability are not only guiding people towards the markets of the world but they are leading them on their journeys through highways of commercial light.

A Photograph with a Moral.

In the accompanying illustration is shown a poster, made from an actual photograph, that is being used in the electric-vehicle campaign of the Edison Electric Illuminating Company, of Boston. As will be seen, photographs have been taken of all of the horse-drawn vehicles and gasoline automobiles formerly in the service of the Edison Company and these were grouped in our photograph with the Boston Common as a background.


FOUR ACRES OF HORSES AND GASOLINE CARS
REPLACED BY
ELECTRIC VEHICLES
The Edison Electric Illuminating Co. of Boston is Replacing with Electric Vehicles All of its Present Equipment -
-The 114 Horse Drawn Vehicles and 39 Gasoline Vehicles as Pictured Here on Boston Common -
Electric Vehicles are Clean, Quiet, Swift and Efficient

POSTER OF BOSTON EDISON COMPANY.

The original is four feet square and it is displayed in the company's electric appliance exchange window where it is attracting a great deal of attention.

Boosting Oklahoma City.

The Oklahoma Gas & Electric Company, Oklahoma City, Okla., one of the H. M. Byllesby & Company properties, is distributing a booklet containing a series of night photographs of the city, showing the extent of street, sign and building lighting. No advertisements appear, the object of the booklet being to boost the town by picturing its progressiveness.

Lighting Rates in Johnstown Reduced.

Voluntary reductions in the electric lighting and power rates charged by the Fulton County Gas & Electric Company in the cities of Johnstown and Gloversville, N. Y., to take effect September 1, so as to apply to bills rendered on and after October 1, 1911, are made in an application by that company to the Public Service Commission.

The rates for lighting are reduced from 5, 8 and 10 cents per kilowatt-hour to 4 and 9 cents per kilowatt-hour, depending upon the amount used by the consumer. The minimum bill of this company for electric lighting remains at fifty cents per month. Electric power rates under the new schedule will be from 1.5 to 9 cents per kilowatt-hour instead of 2.5 to 10 cents per kilowatt-hour.

Central-Station Service Supplied to Denver Mint.

Government buildings have, as a rule, been provided with their own light, heat and power plants instead of relying on central-station service. The United States mint at Denver, Colo., was provided with an excellently equipped isolated plant at the time of its erection several years ago. A few months ago the Denver Gas & Electric Light Company convinced the mint officials that it could supply the electric light and power demands of the mint more economically and reliably than the isolated plant could do. The latter was therefore shut down and central-station service installed. Perfect satisfaction has resulted from the change. The connected load consists of a total of 708.5 horsepower in motors and 1,500 tungsten lamps.

Electrical Business in Italy.

In Italy during the past year twenty-one new electric companies were formed with a capital of 14,000,000 lire, two of them with capitals of 3,000,000 and 2,000,000 lire respectively, four of 1,500,000 lire each, six with a capital varying from 250,000 to 600,000 lire, and nine with less; thirty-two existing companies increased their capital. Only four companies with a capital of barely 3,000,000 lire went into liquidation, and four others reduced their capital; but the companies which dissolved or liquidated were taken over or joined others. On the whole an additional sum of 50,000,000 lire was invested in electrical industries. Of the 118 companies engaged in these industries, fifty paid no dividends, but they were mostly of recent formation; nearly all the other companies declared the same dividends as in previous years, and not a few increased them. Of the twenty-two companies producing or selling electrical material, eleven paid no dividends, but some of these are branches of foreign firms. Of the eleven telephone companies, five paid no dividends, but some of them did not pay any in preceding years.—*Electrical Engineer.*

Chicago Telephone Returns.

The Chicago Telephone Company has paid to the city $159,461 as three per cent of gross receipts of the company for three months ended June 30, an increase of $10,920 over preceding months and $14,920 over last year.

Electric Lighting and Illuminating Engineering

MISCELLANEOUS LAMP CHARACTERISTICS.[1]—II.

BY M. TAPPLEY.

The ideal rating for lamps of every kind would include a polar diagram of candlepower distribution and the mean horizontal, mean hemispherical and mean spherical candlepowers of the unit, together with a sufficient explanation of the conditions under which these were determined. Such a complete rating can hardly be generally expected as yet, though many makers—particularly of arc lamps—closely approach it.

The advisability of substituting a wattage for a candlepower rating has been widely discussed (especially in connection with metallic-filament lamps), and though the addition of the wattage to the candlepower rating would be extremely valuable in all cases, it is hardly desirable to allow its substitution for the latter.

An interesting attempt to obtain a rating figure, which should indicate the illuminating value of arc lamps, was inaugurated by the National Electric Light Association (America) in 1908. The rating number of any particular arc was defined to be the ratio of 250 feet to the distance at which a sixteen-candlepower lamp would give the same normal illumination (as given by the arc at 250 feet). This rating does not take account of the polar distribution of the lamp, and might easily rate unfairly such lamps as the intensive gas burner, the American Nernst lamp, the Jandus arc, and others in which a special distribution suitable to particular services is deliberately arranged. While inferior to a mean hemispherical candlepower or mean spherical candlepower rating—particularly if the latter be accompanied by a typical distribution curve—the N. E. L. A. rating has the merit of simplicity, and should certainly be employed in preference to the old arbitrary "nominal candlepower" ratings.

Candlepower of Units.—This is, of course, largely determined by the candlepower *desired* in various applications, yet more or less standard candlepowers have been evolved to suit convenience of manufacture and utilization: candlepowers, that is, which are employed to a far greater extent than those of intermediate value. Working on a current basis, the mean hemispherical candlepower of various arc lamps is much as follows, the lower limit being approached by alternating-current and the upper by direct-current lamps:—

	Mean hemispherical candlepower per ampere.
Open arcs, pure carbons.....	50—100
Inclosed arcs (pure carbons)....	60—120
Flame arcs, white	180—250
Flame arcs, yellow.....	250—300

Aging, Burning Hours, etc.—It is well known that gas mantles and electric filament lamps deteriorate in candlepower as they grow older; this decadence is generally referred to as aging.

There will clearly be a critical state of decay—varying with the initial cost of the lamp, its wattage and the price of energy—at which it would pay to discard the lamp (or mantle) in favor of a new one; the cost of renewal being balanced by the increased light obtained. This "economical life" is merely that which gives a minimum average cost per candlepower-hour, allowing for all renewals, etc.

In the case of carbon-filament lamps, the deterioration is comparatively rapid, and usually, after some 800 to 1,000 burning hours, the candlepower of the lamp has fallen some twenty per cent below its initial value, and the ultimate life of the filament being (frequently) still far distant, it nevertheless pays to scrap the lamp on the above grounds. The life of a gas mantle is, however, so very curtailed that it does not pay to seek a "smashing point"; the considerable drop in candlepower which occurs as the mantle ages (see Fig. 1) is mainly confined to a very rapid decadence occurring in the first 100 or even 50 hours of life—a fact which further discounts the advisability of any deliberate smashing. On the other hand, the life of the metallic-filament lamps, though still less than that of carbon-filament lamps where low-candlepower, high-voltage units are concerned, has been so far extended that the necessity for discarding must be considered. It is found, however, that the decadence in candlepower is so small in the case of many metallic-filament lamps (see Fig. 2, which is, however, unduly severe on tantalum lamps) that, in view of the high cost of renewals, most lamps of this type are best "burnt to destruction," *i. e.*, run till failure occurs.

Experiments with the latest metallic-filament lamps have shown that after 1,500 hours' life the candlepower may

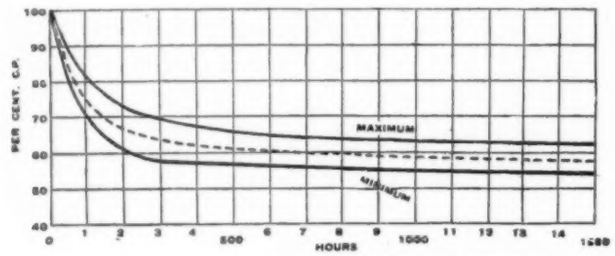


FIG. 1.—AGING OF INCANDESCENT GAS MANTLES.

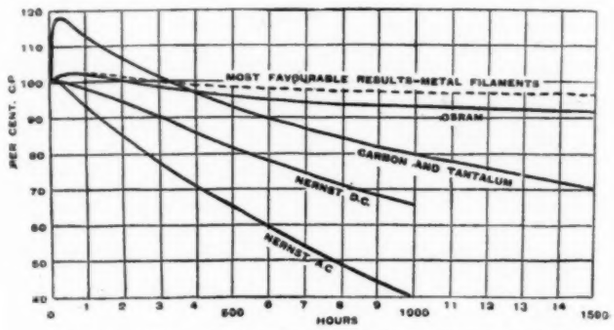


FIG. 2.—AGING OF ELECTRIC INCANDESCENT LAMPS.

1 Abstracted from the *Electrical Review*, London, July 21 and 28, 1911.

be only three to four per cent below its initial value, and to detect such a decadence at all clearly requires considerable care in testing. Photometric errors of two to three per cent being quite common, the mere margin of experimental error might lead to the rejection or retention of a metallic-filament lamp many hours too soon or too long respectively.

Tungsten metallic-filament lamps and incandescent gas mantles may well be used till they fail naturally, but carbon-filament lamps may economically be replaced after their candlepower falls to, say, eighty per cent of its initial value. Tantalum lamps on direct current may be rejected when their candlepower falls to, say, eighty-five per cent of its original value, but on alternating-current circuits they should be burnt to destruction. In many instances, however, glow lamps, even when deteriorated as above, give ample light for the purpose required, and in such cases it would be absurd to deliberately scrap the lamp.

Where minimum cost per candlepower-hour is to be attained, "scrapping" may be practised under the above limitations, but where the desideratum is a maximum number of "sufficient light-hours" for a given expenditure, lamps (so long as above the critical sufficient candlepower) should be used till natural failure occurs. In many cases, lamps discarded from situations subject to the first requirements can be utilized in those coming under the second.

The deliberate discarding of lamps, particularly by users not possessed of photometric or other means of judging luminous decadence and cognizant of the peculiarities of various types, is a practice to be adopted with extreme caution.

The working life of gas mantles is usually about 350 hours; of carbon-filament lamps 800 to 1,000 hours, and of metal-filament lamps till breakage occurs—a somewhat indeterminate and chance-governed period, usually varying from 800 to 1,200 or even 2,000 hours.

Though arc lamps, of the carbon or flaming types, are free from any decadence in candlepower, this immunity must be balanced against the cost of trimming and supplying their carbon consumption. The burning hours of arc lamps can be almost indefinitely extended by the use of magazines containing spare carbons, but for single-carbon lamps, which are still the most commonly employed, 10 to 15 burning hours are usually obtained in open-arc types, 10 to 12 hours in flame lamps and 100 to 150 or even 300 hours in inclosed lamps. In the case of inclosed arcs it is not advisable to go above 150 burning hours, since the globe becomes very foul if left longer unattended, and when opening the lamp for cleaning purposes it is a simple matter to re-carbon its holder.

The candlepower of the Cooper Hewitt mercury arc lamp falls to about seventy-five per cent of its initial value after 1,000 burning hours (mainly owing to a gray film deposit inside the tube) while the quartz pattern has a guaranteed life of 1,000 hours with inappreciable deterioration. Owing to the high cost of both these types, they should be used till natural failure occurs and then returned to the makers in part payment for renewals.

The Moore lamp does not appear to age appreciably, but its breathing valve and phosphorus chamber require overhauling and replenishing once in one or two years, the tube itself being inspected, cleaned and blown through at the same time. Those tubes employing carbon dioxide require more frequent attention.

Supply Characteristics.—The most important supply characteristic, where electric lamps are concerned, is the voltage applied to the lamp terminals. Few lamps can stand variation in the latter without serious change in efficiency and candlepower and even refusal to operate or destruction. The candlepower of filament lamps is very susceptible to voltage changes, and in general the relationship between these quantities may be expressed by an equation of the type—

$$C.P = K\ V^n$$

where $C.P.$ = candlepower; K = constant; V = terminal volts; and n is an index having the following values for various materials (almost independent of the actual filament size.)

	Normal value of n over commercial voltage ranges	n at abnormally low voltages*
Ordinary carbon	6.0	7 —8
Metallized carbon	5.0	5 —6
Tantalum	3.5—4.0	4 —4.5
Osmium	3.5—4.0	4 —6
Tungsten	3.5—4.0	3.5—4

*Say 20 per cent below normal, but filament still incandescent.

Ordinary arc lamps require comparatively close voltage regulation for their satisfactory operation; a certain critical voltage (for mercury arcs, 13 volts; magnetite arcs, 30 volts; carbon arcs, 36 volts) must be exceeded, but excessive pressures must be avoided or the automatic feeding coils will give long, unstable and inefficient arcs. The actual average voltages required by various arcs are shown in the accompanying table, and, though small variations produce a less evident effect than is the case in filament lamps, the rated supply voltage should be adhered to as closely as possible.

Tube lamps employing a mercury arc need a tilting device to strike the arc mechanically or a momentary high-tension discharge to complete the circuit; thereafter a certain critical voltage must be exceeded, but (in the case of the mercury arc) the maintenance of the rated current flow is the important

VOLTAGE AND CURRENT CHARACTERISTICS.

Lamp.	Voltage across Arc.*	Voltage across Terminals.†	Current, Amperes.	Remarks.
Open carbon arc	35-40‡	about 50		Miniature arcs are being replaced by metallic-filament lamps; 6-7 amp. arcs popular in America.
Inclosed carbon arc	70-80‡	about 100	5 to 10	
"Carbone" arc	90-95	100-120	10	Usual size.
Flame (impregnated)	30-40	40-50	5 to 10 and 10 to 20	Two usual ranges of size.
Magnetite	60-65	90	4	Comparable with inclosed rather than with open arcs.
Titanium	50	60	4	
Cooper Hewitt mercury	about 30	50	3.5, 7, 10	Three usual sizes.
Quartz mercury starting	25-30	200	10	"
Quartz mercury running	180	200	3.5	"
Moore tube	...	10,000-12,000	0.3	"
Filament lamps—			Amperes per c. p.	
Carbon (4w./c.p.)	...	100	0.040	
Carbon (at 2½ w./c.p.)	...	100	0.025	100 volts chosen for simplicity and ease of conversion. Current varies inversely with voltage.
Metallic (at 1½ w./c.p.)	...	100	0.015	
Metallic (at 1 w./c.p.)	...	100	0.010	
Nernst (at 1 w./c.p.)	...	100	0.010	

*This voltage amounts almost to a physical constant in each case.
†This voltage may be varied to suit supply and circuit arrangements.
‡Lower voltage generally required on a.c. than on d.c. circuits; also a lower terminal voltage is allowed for series than for parallel running.

factor controlling the efficiency of the lamp, the voltage required varying with the temperature of the tube. Like other arcs, the mercury lamp requires a ballast resistance. In the case of the quartz lamp, the different voltages required during starting and normal running are automatically obtained by using an iron ballast resistance. Instead of running the latter permanently at near red heat (as in the Nernst lamp), it is run thus only during starting; its high resistance then absorbs 130 volts, but as the lamp heats up, its own resistance rises, cuts down the current flowing, and thus enables the iron ballast to cool and absorb, by its then much lower resistance, only about 14 volts.

The Moore lamp is essentially a high-voltage type, and, requiring about 10,000—12,000 volts at its terminals, is naturally supplied through a step-up tranformer from 100 to 200-volt alternating-current mains. The terminal voltage doubtless affects the efficiency of the lamp, though to just what extent appears uncertain. a

The usual current capacities of various lamps are also included in the table as a matter of interest and, in some cases, importance. No special comment is needed on these figures.

Frequency.—The highest frequencies usual on commercial supply circuits (say 150 cycles per second) have no adverse effect on the efficiency or working of electric lamps; on the other hand, if the frequency falls much below 30 cycles per second, flicker is almost certain to be noticeable in the resultant illumination. This is so intolerable that 25 cycles per second forms the lowest frequency at which the lamps at present in use can be operated (apart from any inherent properties of the lamp).

There appears to be little advantage in working at frequencies above 60 or 100 cycles per second, and, indeed, alternating-current arc lamps, however carefully constructed, are liable to operate noisily on circuits of higher frequency than, say, 70 cycles per second. Filament lamps are necessarily (owing to the frequencies available), but without harm, often worked at 100, 120 or 150 cycles, and the mercury arc may be operated on such circuits, though a lower limit is usually desirable.

From 50 to 70 cycles per second thus appears to be a convenient frequency for lighting circuits in general, and particularly for arcs (open, inclosed and flame) and Moore lamps.

Power-Factor.—It is not generally realized how considerably a purely lighting load may depart from unity power-factor (on alternating-current supply). The power-factor of filament lamps is practically 100 per cent, but few arc lamps have a higher power-factor, terminal to terminal, then 85 per cent, or rarely 90 per cent, while in many instances this figure falls to 70 per cent; the power-factor of the arc itself is usually 85 to 90 per cent. In general, 80 per cent may be assumed for the power-factor of the whole arc lamp, and 90 per cent for that of the arc alone. The power-factor of a mercury arc is from 80 to 85 per cent, while that of a Moore tube may be 90 per cent or more. Needless to say, these facts must be allowed for in the layout of any arc-lighting scheme.

Incandescent Gas Mantles.

The discovery made some little time ago that ramie is much more effective than cotton for the construction of incandescent gas mantles, because the separate fabric of the yarn employed remains fairly wide apart and presents a larger glowing surface, has led to an increased lamp efficiency. It is now reported, according to the *Journal of the Royal Society of Arts*, that experiments with artificial silk show that the fibers of this material maintain their individuality to an even greater extent than ramie, and the mantles themselves are said to be much more elastic, supple, and durable. The Deutsche Gasglühlicht Company has been doing a great deal of research work on these lines, and intends shortly to place a new mantle on the market, the essential difference of which from existing types lies in the fact that it is made of artificial silk. It is especially adapted for street lighting, and for all purposes where high-pressure gas is employed.

Electric Lamps Per Capita.

There are in Boston the equivalent of 1,232 sixteen-candlepower electric lamps per 1,000 of population, in New York 859, in Chicago 730, and in San Francisco 660. European cities show much smaller figures, St. Petersburg having 440; Vienna, 246; Paris, 185, and London, 184.

Illuminating Gas from Sewerage.

The municipality of Brünn, Austria, has decided to filter the town sewerage and to distil the solid residue for obtaining illuminating gas. Analyses made at different periods from 1906 to 1909 show that at Brünn one cubic meter (220 gallons) of sewerage yields on an average 1,666.4 grams (3.7 pounds) of solid residue. The yield in gas of the latter amounts to 23.8 cubic meters (480 cubic feet) per 100 kilograms (220 pounds) of solid residue; the gas has a calorific value at least equal to that of coal gas, and gives a better light than the latter.

Electrical Exports for July.

The Bureau of Statistics of the Department of Commerce and Labor, Washington, D. C., has issued its monthly summary of the imports and exports of the United States for the month of July. From these statistics the following data relative to the exports of electrical products are obtained.

The figures for July are disappointing. A falling off occurred in both appliance and machinery exports, not only compared with the preceding few months, but even as compared with the corresponding month a year ago. This is shown by the following comparative data:

Month.	Electrical Appliances.	Electrical Machinery.	Total.
July, 1911....	$707,214	$584,715	$1,291,929
June, 1911....	884,839	825,091	1,709,930
July, 1910....	839,059	745,419	1,584,478

The principal countries to which electrical products were sent in July and the value of these shipments was as follows:

Countries.	Electrical Appliances.	Electrical Machinery.
United Kingdom	$ 61,856	$ 96,500
Canada	266,075	135,416
Mexico	30,599	74,097
Cuba	53,465	4,781
Brazil	131,232	61,881
Japan	22,564	32,111

Coal Production Breaks Records.

For the first time in the history of the United States, the coal mines of the country in 1910 were credited with an output exceeding half a billion short tons, the combined production of anthracite, bituminous coal, and lignite having amounted to 501,576,895 short tons, with a spot value of $629,529,745.

Exports of Copper.

Exports of copper for the week ended August 31 were 6,303 tons. Since August 1 the amount given is 27,893 tons, as compared with 27,976 tons for August last year.

Telephony · Telegraphy and Wireless

TELEPHONE CABLE TRANSMISSION.[1]

BY JOHN B. ADAMS.

It is my purpose in presenting this paper, to place before telephone men reliable and practical information relating to cable transmission, specifications and manufacture, which, it is hoped, will prove of value to them in solving transmission problems. There have been issued pamphlets and catalog literature, purporting to treat the question of transmission of telephone currents in cable, along practical lines, but these unfortunately contain fundamental statements, which, to any one conversant with the present-day principles of the art, are known to be erroneous, and the formula expressing the loss in transmission is so misstated as to lead to entirely erroneous conclusions and results.

TRANSMISSION.

The factors which determine the transmission efficiency or talking value of any circuit, are resistance, capacity, inductance and insulation. As applied to a telephone circuit made up of two copper conductors of equal size, insulated with dry paper, twisted together and inclosed in a lead sheath, as a pair of conductors in ordinary telephone cable, it has been found as a result of actual transmission tests and measurements, that the inductance and leakage are so small compared with the resistance and capacity, as to be entirely negligible in their effect on the transmission.

The loss of volume in transmission, or attenuation of the current, as it is called, in a telephone-cable circuit, is therefore dependent only upon the resistance and capacity, and the loss may be stated as being proportional to the square root of the product obtained by multiplying the resistance of the loop in ohms, by the mutual capacity in farads; i. e. Loss$=K\sqrt{R}\sqrt{C}$ in which R is the loop resistance, C the mutual capacity and K a constant assumed as equalling the average frequency of the voice currents.

As an example, in the calculation of transmission losses in cable, suppose it is required to find which of the following cables will give the least transmission loss per mile, and also the length of each cable which will give the same loss or the same volume of transmission:

	Cable No. 1.	Cable No. 2.
Conductors, gauge B. & S.....	19	22
Resistance, ohms per mile loop....	86	172
Mutual electrostatic capacity.....	0.075	0.075

Applying the formula for transmission loss as above stated:

Loss in cable No. 1 =

$$K\sqrt{86\times 0.075} = 2.54\,K$$

Loss in cable No. 2 =

$$K\sqrt{172\times 0.075} = 3.59\,K$$

Therefore, the loss in cable No. 2 is 3.59/2.54 or 1.41 times as great as in cable No. 1 or, with the same capacity, 1.4 miles of No. 19-gauge cable will give the same volume of transmission, i. e. the same talking efficiency, as one mile of No. 22-gauge cable. This result has been confirmed by a large number of transmission tests. With the formula for loss in telephone cable, incorrectly stated as being proportional to the simple product of resistance and capacity (the old "K R law"), the loss in the No. 22-gauge cable would be twice that for the No. 19-gauge cable, a result which has been proven to be entirely incorrect by actual test.

TRANSMISSION STANDARD.

In calculating values of telephone transmission, it will be found convenient to adopt some standard for transmission loss, i. e., some unit of loss in terms of which the losses in any circuit can be expressed. In the absence of any accepted name for such a unit, a standard of this description which has been quite generally adopted by telephone engineers in this country, is a cable having a resistance of 88 ohms per loop mile (44 ohms per conductor mile), and a mutual electrostatic capacity of 0.06 microfarad per mile, with no inductance and no leakage. This is known as a standard cable and losses expressed in terms of this unit are referred to as losses in miles of standard No. 19-gauge cable, or simply miles of standard cable.

As an example of the use of this standard, in calculating losses, suppose it is required to find the relative talking efficiency of the following circuits:

Gauge.	Loop Resistance per Mile.	Mutual Capacity per Mile.
13.....	21.5	0.07
16.....	42.5	0.07
19.....	85.0	0.075

13-gauge cable $\sqrt{\dfrac{21.5\times 0.07}{88\times 0.06}}$ = 0.534 mile standard cable

16-gauge cable $\sqrt{\dfrac{42.5\times 00.7}{88\times 00.6}}$ = 0.75 mile standard cable

19-gauge cable $\sqrt{\dfrac{85\times 0.075}{88\times 0.06}}$ = 1.1 miles standard cable

That is, the losses in one mile of the above cables are equivalent to the losses in 0.534, 0.75 and 1.1 miles of standard cable.

STANDARD GRADE OF TRANSMISSION.

By a standard grade of transmission is meant the standard of transmission loss, including the loss in switchboard and substation apparatus, as well as that in the portion of the circuit between apparatus terminals, commonly called the line, which is considered allowable for any particular class of service. This question of a standard transmission is of increasing importance as toll or long-distance lines are extended, and it is of the utmost importance that it be carefully considered in the development of new plants or in planning extensions to existing ones.

While economical consideration usually governs this question it should be borne in mind that standards of transmission have been gradually raised by the leading telephone companies throughout the country in meeting the increasing demands for long-distance telephone service, who in so doing have found the additional investment necessary a profitable one from the standpoint of service efficiency. A few years ago a circuit having a loss of 40 miles of standard cable was considered a satisfactory one;

1 Abstract of paper read at the Boston convention of Association of Railway Telegraph Superintendents. From *Telegraph and Telephone Age*.

today, however, a loss of over 30 miles is not considered satisfactory commercially. In general it may be said that a conversation over a telephone circuit under very favorable conditions cannot be carried on where the transmission loss is greater than the equivalent to 45 miles of standard cable.

STANDARD GAUGES OF CABLES.

The question of the proper gauge of wire in a cable for any particular class of service, or the gauge of cables in general to be used in the telephone plant, is dependent upon local conditions. These conditions are: 1. Grade of transmission considered satisfactory. 2. The ratio of the number of trunks to the number of subscribers' circuits entering a central office. 3. The average length of subscribers' and trunk circuits. 4. The ratio of local to toll business originating in the district or districts under consideration.

The standard wire gauges in use in cable at the present time are: 13, 14, 16, 19, 20 and 22 B. & S., and it is believed that this range of sizes will satisfactorily and economically meet any ordinary requirements which may arise. Sizes outside of this range can, of course, be used, but No. 22 is about as small as is desirable for mechanical reasons, and while conductors larger than No. 13 B. & S. have been used in this country and abroad, with further increase in the transmission efficiency, it is doubtful if the expense of such cable is justifiable except in special cases. In general the classes of service for which the different gauges are used are as follows:

Subscribers' loops	Nos. 22, 20, 19, B. & S.
Local trunks	No. 19.
Toll-board trunks	Nos. 16, 14, 13.
Toll lines in cables	Nos. 16, 14, 13, 12 and 10.

It is often found economical to use a combination of these conductors in the same cable, as, for instance, 50 pairs of No. 16 gauge with 50 pairs of No. 19 gauge; this is known as composite or combination cable. A cable of this class can be used economically where subscribers' and high-efficiency trunks are required along the same route, the economy being effected in the saving of lead in the cable sheath.

INSULATION.

Dry air is the ideal dielectric between conductors for telephone transmission, but inasmuch as the conductors in cable could not be kept permanently separated with an all-air dielectric, a separator of one or more paper ribbons is applied spirally to each conductor in such a manner as to include as much air around the conductor as possible, and to separate the wires of a pair as much as possible. The spiral application of the ribbon of paper has been found much superior to laying it around the conductor longitudinally, as it secures a greater amount of air space and a more perfect mechanical separation. Pure Manila rope paper of a suitable thickness, overlapped in applying sufficiently so that each conductor will remain completely covered under extreme conditions of bending, has been found superior to any other material, both electrically and mechanically.

The two wires of a pair with different colored insulation for identification are twisted together, the requisite number of pairs cabled or stranded up concentrically in layers, in reverse directions, and the whole wrapped with heavy paper for keeping the core in shape and for additional protection against the grounding of the conductors in the outer layer to the sheath. The core is then dried or desiccated either in vacuum or drying ovens at a temperature sufficient to vaporize all hygroscopic moisture in the paper, and when perfectly dry the core is immediately covered with a lead pipe, the ends of which are hermetically sealed.

MUTUAL VS. GROUNDED CAPACITY TEST.

There are two general methods of determining the electrostatic capacity of cable for telephone service, the difference between the two being the connecting of the wires under test.

1. *Grounded Test, Sometimes Called Regular Test.*—This is the older method and consists of measuring the capacity between one wire and all other wires, including its mate, grounded to the sheath.

2. *Mutual Test.*—This consists of measuring the capacity between one wire and its mate, all the other wires being grounded to sheath.

Considerable argument has arisen concerning the selection of one of the above tests as the proper one to use, and it has even been hinted that some manufacturers in meeting specifications, have used the mutual test which gives a lower capacity than the grounded, when it was understood that the grounded test should apply. The grounded test being the older method, it is always understood that it shall apply unless the mutual test is specified, and this is a general rule followed by all reputable manufacturers.

In dry-core telephone cable of the usual construction, the mutual capacity will be less than the grounded capacity, and will vary between the limits of 60 to 75 per cent of the grounded capacity, depending upon details incident to the manufacture of the cable. The hard-and-fast rule of "mutual = 0.66 of grounded," as stated by some cable makers, does not hold in practice and cannot be depended on for accurately converting grounded capacity into mutual capacity, or vice versa.

As the ratio of mutual to grounded capacity is not constant, the question of which should be specified to secure a cable of the required transmission efficiency becomes important. In metallic-circuit service, it is believed that, since the mutual rather than the grounded capacity is the constant of the cable directly indicative of its value as a talking circuit, the mutual is the proper test to apply, and this is now current practice among many of the larger telephone companies in this country and abroad. As there is a material difference between the results of the two tests applied to the same cable, it is, of course, important that the method of testing be specifically stated in specifications.

LEAD SHEATH.

In dry-core cable the life of the cable is affected by moisture or mechanical damage and is evidently dependent upon the integrity of its protecting lead sheath. The greatest care is therefore exercised to insure a sheath free from pin holes or other defects. The practice in regard to the thickness and composition of the sheath for telephone cable varies with different purchasers, but as a general guide for Nos. 22, 20 and 19-gauge high capacity cable, recommended minimum thicknesses are as follows:

5 to 50 pairs	5/64-inch wall
60 to 100 pairs	3/32-inch wall
120 to 200 pairs	7/64-inch wall
200 up	⅛-inch wall

For low capacity cable an additional 1-64 inch thickness in each case should be used.

I recommend an alloy of lead with a small percentage of tin for all large and soft-core cable, and for small cable which may be subject to vibration or swaying by the wind. In large cable especially the addition of a small percentage of the tin in the sheath is a much more economical way of securing additional strength and stiffness than to increase the wall thickness.

Industrial Power

THE FIXATION OF ATMOSPHERIC NITROGEN.—I.[1]

BY JOHN WOODS BECKMAN.

The farming industry and the fertilizer industry are of the utmost importance to the maintenance and well-being of the human race. The amount of capital invested in the latter can not be compared with that invested in the former; but were it not for fertilizers, the returns from the farming industry would be meager; the cost of living would reach a point unheard of, immigration would cease and an industrial "ice period" would set in. Not many years ago the growing capacity of the soil of this continent was so great that no fertilizers were in demand. Most of the United States was virgin soil then, and when plow and harrow made their first marks in it, crops of untold size were harvested. But nature asserts herself, and demands fresh nutriment to replenish the exhausted ground. People are awakening to the fact that the field that is regularly fertilized will possess a yielding capacity that can be maintained at a uniform level.

Nitrogen, phosphorus, potash, oxygen, hydrogen and carbon are the elements that are essential to plant life. The growing plant takes hydrogen and oxygen from the moisture in the air in the shape of rain or dew, and from the rotting roots and straw of earlier crops, from which it also derives its carbon.

Nitrogen, phosphorus and potash are carried off the fields with the crops, and if these elements were not artificially re-furnished, the natural supply would not correspond to the demands made upon it. The phosphate industry, the potash and kainit industry, and the nitrogen industry are built up on this demand. The most necessary and important of these three is the nitrogen industry, and the sources from which nitrogen is derived are many. Horses' hoofs, chickens' feathers, slaughter-house refuse, guano, Chilean nitrates and ammonium sulphate are some of the sources from which bound nitrogen is obtained for fertilizer purposes. Even subtle things like micro-organisms assist in collecting this most valuable element and finally the genius of man has developed ways of fixing it in the shape of ammonia, nitrates and carbon-nitrogen compounds generally known as "cyanamid" or "lime nitrogen."

The earth has never been so thickly populated as at present, nor has civilization been so widespread. The natural consequence of an increased population is a greater demand for food, which in turn requires a scientific and systematic tilling of the soil. The herding together of great numbers of people in large cities, together with increased facilities for transportation, which a higher civilization has brought, prevent the waste products of crops from benefiting the soil from which they grew. In large communities the nitrogenous materials which might be of benefit to the farmer are done away with for sanitary reasons, and the nitrogen thus liberated returns to the air.

There is a permanent drain of nitrogen from the soil and the farmer must find sources from which it can be abundantly and readily obtained. Nature herself has furnished the greatest available sources; and, too, through a complicated civilization, various manufacturing by-products have been found of value as fertilizers.

The greatest of all nitrogen reservoirs — the atmosphere — although known always, has only recently been made available through the efforts of man.

Many of nature's phenomena produce nitrogenous compounds from the air. In thunderstorms considerable amounts of nitric acid are formed, and a volcanic eruption produces other compounds such as ammonia, etc. Even in a heavy rain, appreciable amounts of nitric acid can be detected. But these are not sufficient to supply the fields with their needs.

The economic fixation of atmospheric nitrogen is becoming one of the most important problems for the human race to solve. Everything tends to diminish the available bound nitrogen on the crust of the earth, and in the same ratio the demand for it is growing. The Chilean saltpeter deposits are severely taxed, and even though authorities differ as to when they will become exhausted, yet all agree that they must eventually be drained. Then the farmer and humanity must turn to artificially produced fertilizers.

Just as matter is indestructible, so the supply of nitrogen is inexhaustible. It is estimated that 33,880 tons of nitrogen hang over every acre of land. This stock is inexhaustible, for whenever a nitrogenous substance is decomposed, nitrogen is given off into the air, thus keeping intact the supply, despite the inroads made upon it by industries.

Nitrogen has always been looked upon as an inert gas, and it has been considered very difficult to combine it with other substances. But of late years, knowledge regarding electricity has increased and products—many of them perfectly new—have resulted. General chemistry has developed greatly and brought with it an increase of analytical possibilities which have proven that nitrogen is not so inert as had been supposed. Many metal compounds formerly thought to be the metals themselves have been found to be their nitrides or similar substances.

Up to the present time the fixation of atmospheric nitrogen is distinctly an electrochemical problem. All processes for fixing it that have been commercially developed are dependent upon electrical force, either for the actual fixation or for the production of the material with which the nitrogen is to combine. Undoubtedly the future development of the fixation of atmospheric nitrogen lies along these same lines.

THE "CYANAMID" OR "LIMENITROGEN" PROCESS.

About twenty years ago two German scientists, Frank and Caro, were actively engaged in a research for cheapen-

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ing the manufacture of cyanide for gold extraction. They found that barium carbid would bind nitrogen with great avidity, if they were heated together. Barium being a comparatively expensive element, and its presence in the crust of the earth being scarce compared to that of calcium, they turned to calcium carbid with the expectation of finding a similar result. To their surprise they obtained not cyanide of calcium but a product containing calciumcyanamid, which, when fused with an alkaline salt, gave cyanide. The production of cyanides from the cyanamid became secondary after the discovery that the cyanamid (which got the meaningless names of "nitrolim," "Kalkstickstoff" and "lime nitrogen") had qualities which made it comparable with many of the standard fertilizer products on the market.

The chemical composition of the substance produced by Frank and Caro was a heterogeneous mixture of calciumcyanamid, calciumoxide, graphitic carbon, various impurities like calciumphosphide, calciumsulphide, etc., and calciumcarbid. The underlying principle of the manufacture of "limenitrogen" is the affinity nitrogen has for the carbid of calcium. When the carbid of barium is treated with nitrogen, barium cyanide is the result. A very simple reaction; on the other hand, when nitrogen is added to calcium carbid, beside the cyanamid thus formed, there is a simultaneous splitting off of one of the carbon atoms present in the carbid. Of the following reactions the first shows the barium carbid reaction, the second the calcium carbid reaction:

$$BaC_2+2N=Ba(CN)_2$$

$$CaC_2+2N=CaCN_2+G.$$

From the last reaction, it is evident why free carbon which appears in the graphitic modification is present in the product known as "limenitrogen."

The commercially produced carbid, which is used in manufacturing this substance, is not a pure product but usually contains a good deal of free lime. The general principles underlying the making of carbid in an electric furnace are well known. Lime and carbonaceous materials, such as anthracite or coke, are mixed together in certain proportions and submitted to the heat of an electric arc, when the following reaction takes place:

$$CaO+3C=CaC_2+CO.$$

Neither the carbon nor the lime used are pure products and naturally most of the impurities present in these materials will be carried by the carbid. The lime percentage may be varied with impunity and in the case of the manufacture of "limenitrogen" it acts as a diluent in the final reaction. The coke and anthracite contain sulphur and the lime as a rule contains some phosphorus and these elements form calciumsulphide through the action of the heat and the carbon.

The carbid present in the limenitrogen is unavoidable. The practical operation limits the length of time the carbid may be submitted to the nitrogen gas. There is a point when it is more expedient to consider the reaction completed rather than to try to bind the last amount of carbid. The amount of carbid varies considerably with conditions. Thus the impurities present in the finished "limenitrogen" are accounted for.

The manufacture of "limenitrogen" is distinctly different from the nitric acid process. In the latter case the gases of the atmosphere are submitted to a high temperature and there is no need for adjusting the concentration of these; but in the limenitrogen industry one of the preliminary steps of manufacture is the separation of the oxygen and nitrogen present in the atmosphere. There are a number of ways of doing this, some of which are of theoretical interest only; others have been applied practically. Two processes, workable on a commercial scale, are in use at present. One depends upon the affinity of oxygen for metals, and the facility with which some of them may be reduced again to their original condition if treated with a reducing gas at a raised temperature. The other process is one of fractional distillation. Nitrogen and oxygen having different boiling points, it is possible to obtain a stream of nitrogen practically pure by carefully regulating pressure and temperature.

The first mentioned process is generally known as the "copper process." Copper in a very fine condition is mixed with a porous material capable of standing considerable temperature; this mixture is then inclosed in an airtight vessel and heated. When air is blown through this vessel the following reaction takes place:

$$Cu+O+4N=CuO+4N.$$

When the copper has been oxidized until it will no longer deliver pure nitrogen, the copper oxide is submitted to a reducing gas such as methane and the following reaction takes place:

$$4\,CuO+CH_4=4Cu+CO_2+2H_2O.$$

On paper these reactions seem simple indeed, but in reality, where tons of copper are alternately oxidized and reduced, there is a continuous accumulation of heat, both of these reactions being exothermic. This heat is exceedingly hard to cope with and during continuous operation the temperature will reach the melting point of the copper, forming globules of the metal and thereby decreasing the active surface.

The liquid-air process, depending upon the different boiling points of nitrogen and oxygen, has been frequently described in articles in the technical periodicals. Suffice it to say that there are two different systems, one working under considerably higher pressure than the other.

The nitrogen delivered for use in the manufacture of limenitrogen must be as pure as possible. In the liquid-air process the carbonic acid in the air has to be carefully absorbed before the air is compressed, in order to prevent its freezing out in capillary tubes.

In the copper process the formation of a considerable amount of carbonic acid gas is unavoidable, due partly to the fact that some of this gas is entrained in the material after the reduction and also that some of the methane, having decomposed, deposits carbon on the copper. When the air comes in contact with this carbon, carbonic acid will be formed. This gas has to be carefully excluded in order to prevent bad effects on the carbid treated; likewise all moisture must be carefully removed from the nitrogen. The carbonic acid is absorbed by submitting the nitrogen to caustic soda, and the gas is dried by passing it through towers charged with caustic lime and anhydrous chloride of lime.

The carbid used for the absorption of the nitrogen should be made of as pure materials as circumstances permit. This should not be of too high percentage, as the heat of formation of cyanamid is great.

Approximately one-half ton of finely ground carbid is placed in large iron cylinders and various devices combine to give the nitrogen free access to the material. These "cans" are placed in receptacles that are hermetically closed. A resistor is passed through a central tube, which penetrates the mass

of carbid, and by the application of current, brings it to a high temperature, while nitrogen is simultaneously admitted; the reaction starts and travels through the material, thereby converting it into "limenitrogen." The length of time for completing the reaction varies considerably with conditions, the average time being from 40 to 60 hours. The speed of the reaction increases to a maximum after which time it steadily decreases until it reaches a point where the fixation is practically completed. The temperature during absorption has run as high as 2,000 degrees Fahrenheit. The limenitrogen must be allowed to cool in the hermetically closed receptacles in order to prevent its burning if exposed to the air when hot.

The resulting product finally appears as a large cylindrical cake which is readily removed from the can in which it is made. Its color is greyish black, and here and there distinctly defined minute crystals of calciumcyanamid may be found. The product thus obtained is broken, then milled, and after being treated with water, in order to rid it of carbid and to partly hydrate the free lime present, it is ready to be put on the market.

This process has several advantages, the greatest of which is that a very large quantity of nitrogen is fixed per kilowatt-hour. In a recent paper read before the American Electrochemical Society, it is stated that one kilowatt-hour will bind 65 to 75 grams of nitrogen in the form of calciumcyanamid. These figures include the amount of power required to produce the necessary quantity of carbid. They are nearly four times better than those published in reference to the nitric-acid process.

Another advantage is the facility with which the nitrogen is absorbed and bound. In the manufacture no delicate regulation of temperature is necessary. The present mode of operation is rather crude; the only care necessary being the more or less delicate handling of the materials. On account of these conditions it is impossible to regulate all the receptacles in which the product is made, so that it comes out uniformly with the same per cent of fixed nitrogen; and, too, the time of absorption varies.

The greatest fault in this process is undoubtedly the small-unit system. The labor of looking out for hundreds of "ovens" is quite a consideration, and naturally the initial cost and the upkeep of such a plant must be greater than when large units or single units give the whole output. The chances for disturbing influences from without are great, so that unevenness of the product is unavoidable.

The limenitrogen process differs essentially from that of the nitric acid in that the raw materials used in the latter can be obtained in unlimited quantities and without cost, while those used in the former (nitrogen and carbid, originally derived from coal and lime), are expensive to procure.

The resulting limenitrogen is very rich in nitrogen, and if it were a comparatively stable product, as nitrates ordinarily are, it could be called ideal; but the calciumcyanamid—the fertilizing ingredient—is not a stable product and is still less so when together with the unavoidable calcium oxide. An Italian investigator has made extensive researches in this line and has found that the material polymerizes (forming various complex compounds), just as well as it decomposes (forming urea and ammonia in volatile form). It is only necessary to expose the material to atmospheric conditions, in order to obtain the various products.

In case any carbid is left in the finished product there is always the danger of its decomposing and forming acetylen, which, if mixed with air, becomes a highly explosive gas mixture. By treating the limenitrogen with water the carbid may be eliminated, but by so doing the product undergoes various chemical changes; not only does the carbid decompose, but the free lime may be partly or fully slacked. When lime is hydrated, considerable heat is liberated, and with the increase in temperature, ammonia is liberated and other compounds are formed.

The finished material is extremely dusty, and of rather an offensive nature. This dust may be overcome to some extent by treating the limenitrogen with some heavy oil, similar to the treatment applied to roads to settle the dust.

The graphite present is supposed to be of some value as an antitoxin. The good points of the product are distinctly commercial.

In the fertilizer trade it is known as "a good drier." A "good drier" is a substance which while not acting in any way upon the available phosphoric acid nevertheless absorbs the free phosphoric acid present in the phosphates, thereby giving to a fertilizer a nice constitution making it easy to pass through the drills out on to the fields. The free lime in the limenitrogen seems to have the desired effect and when it is mixed dry with the phosphates it does not seem to affect the water-soluble or available phosphoric acid to any degree, even if the mixtures have been stored for some time.

It is interesting to note the effect of limenitrogen upon human beings. If inhaled, it is apparently assimilated by the blood, yet does not noticeably affect the system unless alcohol is partaken of. Even a small quantity of this drug will soon show its result, much blood being forced into the head, the face becoming flushed and puffy and an insufferable headache setting in.

The causticity of the substance makes it hard for laborers to handle, especially in warm weather when perspiration is abundant. The caustic lime dust settles on the body and very ugly sores are formed, painful and difficult to heal.

Since carbid is one of the raw materials necessary in the manufacture of limenitrogen, it is dependent upon cheap water power for its economical production in Europe. The average cost for the production of one ton of carbid is between $30 and $40, and the cost of making a ton of limenitrogen from this carbid would be considerably higher.

The patents for this process are owned by a firm in Italy who license various other companies in different countries where limenitrogen is made. Licenses have been given to companies in the following countries: Norway, Germany, Bavaria, Switzerland, Italy, France, Japan, Hungary, and the United States.

(To be continued.)

Electrolytic Disinfecting Fluid.

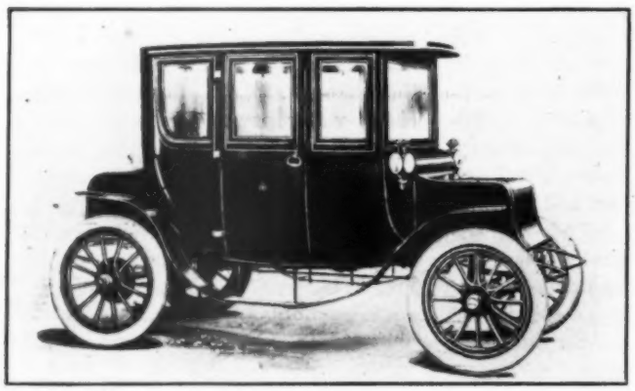
Electrolytic disinfecting fluid has been manufactured to the extent of 50,726 gallons during the past year by the Health Office in Poplar, England. The cost for material and bottles was $415. 8,182 kilowatt-hours at three cents per unit cost $245. The cost of the plant was about $5,300. It can deliver 400 gallons having a strength of 4.5 to 6.1 grams per liter in eight hours. There is a steady demand for the fluid from the public.

New Electrical and Mechanical Apparatus and Appliances

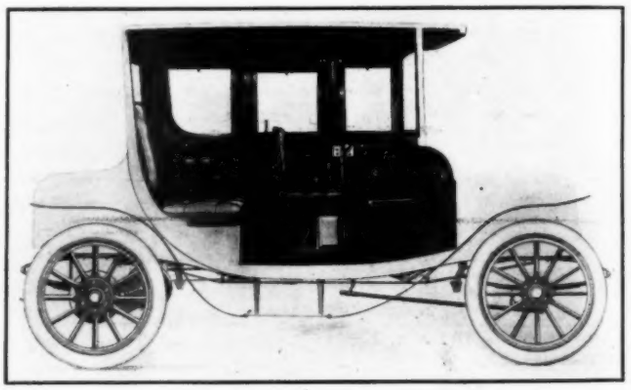
New Waverley Electric Limousine.

The Waverley Company, of Indianapolis, offers this year something entirely new in the automobile world—an electric limousine seating five passengers and giving the driving occupant a wholly unobstructed view through the front window.

The difficulty that has always presented itself when an electric of this type has been proposed is the unusual dimensions of the car. Not until the present year has it been practicable to build an electric with a wheel base of 104 inches, a body sill of 129 inches and a length over all of 144 inches. The very latest improvements in batteries, tires and gears are all necessary to give such a car the requisite speed and mileage.



WAVERLEY LIMOUSINE.



INTERIOR OF LIMOUSINE.

Those are the dimensions of the new 1912 Waverley and it is emphatically stated by the Waverley management that all the speed and mileage needed for any town car will be found in its limousine electric.

The car has practically the same regular equipment as the Waverley roadster that recently made 1,400 miles in 124 hours' running time on a tour extending through four states. The chief difference is in the wheels and tires which are 34 by 4 inches rear and 34 by 3.5 inches front.

The accompanying illustrations show the seating plan and interior arrangements of this new Waverley. The design of the car is a refinement upon the lines of the town chariot of French design, used in the period of the first empire.

The mechanical features of the Waverly electric limousine include the Waverley multipolar motor, with its 360-per-cent overload capacity, feeding abundant power through a silent flexible gear to the transverse shaft of the high-efficiency shaft drive, which again transmits 98.7 per cent of the power received through herringbone gears to the full floating rear axle, all gears, bearings and shafts being housed in dust- proof cases and running in a constant bath of oil.

Battery and motor are completely under the control of the no-arc controller, that provides for four speeds, either forward or backward, but cannot be started in either direction on any speed but the low, a Waverley feature that adds greatly to the safety of the driver and passengers.

An option is allowed with this car on either side lever or wheel steer with sector pinion. Internal expanding brakes with twelve-inch drums and motor shaft contracting brake, operated by convenient foot pedals, complete the safety controlling system.

Full elliptic springs, with platform springs front and rear, support the evenly balanced weights of the body and mechanism, no share of which falls uncushioned by springs on the axles or tires. Thirty-four-inch wheels, with fast 3.5-inch front and four-inch rear tires, form the regular equipment. Any approved battery is installed.

A New Electric Water Heater.

A demonstration was given recently by the Electric Water Heaters, Ltd., Glasgow, Scotland, of a new apparatus for the heating of water by means of electric current. The apparatus consists of one or more porcelain tubes packed with carbon granules, the tubes being so arranged that water flows through them freely, and the granules being brought into electrical circuit, the water takes up the heat generated, thus producing hot water.

The carbon granules are of uniform size, carefully packed, and are prevented from escaping through the tube ends by specially constructed carbon blocks. The cold water from the main entering at one end of the tube must percolate through the carbon granules. These granules being brought into electrical circuit the resistance thus set up generates heat, and each single granule might be compared to a small furnace imparting its own quota of heat to the water in direct contact with it. Thus there is a very large heat-generating suface in contact with the water, and in this way an almost instantaneous rise in temperature is obtained.

Among the advantages claimed for the new apparatus are: any temperature may be obtained in five seconds from the cold water supply; there is no loss of heat by radiation; water is heated only as used, so that there is no loss of current; hot or cold water may be obtained from the same tap; and the water is sterilized.

Tests carried out by independent authorities have shown that there is a bactericidal action on the water which passes through the heater, so effective that the water may be rendered absolutely sterile.

A New Metal Flush Type of Inter-Phone Set.

The Western Electric Company has added to its many types of inter-phones a new metal flush set, which on account of its handsome appearance, convenience of installation, compactness and general efficiency, represents the highest type of intercommunicating telephone for residence work. This set,

FIG. 1.—INTERPHONE SET.

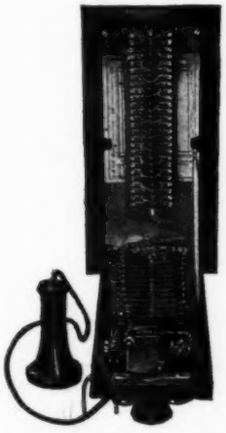


FIG. 2.—INTERIOR OF INTERPHONE.

known as the No. 1335 type, is made in capacities for 12, 16 and 24 stations, the one shown in Fig. 1 being a twenty-four-station type.

One of the features of this set is the metal outlet box which is separate from the set and can be built in the wall while the house is in process of construction. All the apparatus is mounted on a face plate, which is hinged at the bottom so that connections in the outlet box are easily accessible when the face plate is removed. This makes all the apparatus readily accessible, should inspection or adjustment be necessary. Considerable adjustment is allowed in mounting the inter-phone proper to the outlet box. This enables the set to be mounted straight even if the outlet box should be slightly out of plumb.

While the set is compact, it is not crowded, and a concealed binding-post receiver adds to its neat appearance. Conversations between pairs of stations at the same time are perfectly quiet, that is, there is no evidence of the annoying interference known as cross talk. As many conversations can be carried on at once as there are pairs of stations.

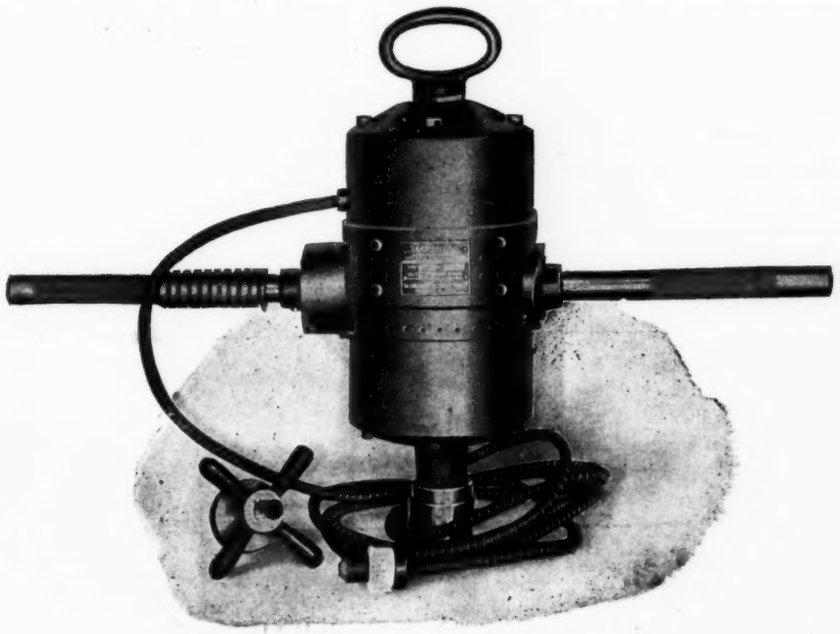
By winding the coils of the vibrating bells to ten ohms, the current necessary to ring long or short lines is more nearly equalized. A high-resistance transmitter and receiver are used with the set which insures low battery consumption.

International Continental Telephone Line.

It is stated that a telephone line is to be constructed between France and Austria, passing through Germany and Switzerland. The Austrian administration was the first in Europe to equip long overhead lines with Pupin coils.

Cincinnati Portable Reaming and Drilling Machine.

A new design of reaming and drilling machine of the portable electric type, recently brought out by the Cincinnati Electrical Tool Company, Cincinnati, Ohio, is illustrated herewith. The machine is especially intended for drilling and reaming in structural work and bridge building, but can, of course, also be used wherever a portable tool is required. The special feature is that the gearing, which runs in grease, is entirely inclosed, so that there is no chance for the lubricant to work into the armature winding. On the left-hand handle a quick-acting switch is provided, actuated by the corrugated sleeve shown. This sleeve slides back and forth, cutting out the current when in an outward position and closing the connections when moved inward.



PORTABLE REAMING AND DRILLING MACHINE.

The motor is series-wound, and of the air-cooled type. Small holes are provided in the frame for cooling the motor. The latter is geared down to the proper speed for the drill or reamer, the spindle speeds being 200, 350 and 500 revolutions per minute, respectively, for the three sizes manufactured. These sizes have a maximum capacity of 0.5, 1 and 1.25-inch diameter drills or reamers.

The gears are made of high-carbon steel and hardened, and as they constantly run in grease they will wear indefinitely. The spindle in the largest of the three sizes made, has a hole for a No. 4 Morse taper shank, the medium size

for a No. 3 and the smallest size for a No. 2 shank. The two largest sizes have screw-feed for the drill spindle, the spider for the screw-feed being shown beside the tool in the illustration. Instead of the Morse taper, the smallest size may also be provided with a chuck.

The machine is equipped with Hess-Bright ball bearings throughout, no bronze bushings being used for any of the bearings. The weight of the three sizes is about 25, 70 and 85 pounds, respectively.

Model Building for Small Manufacturers.

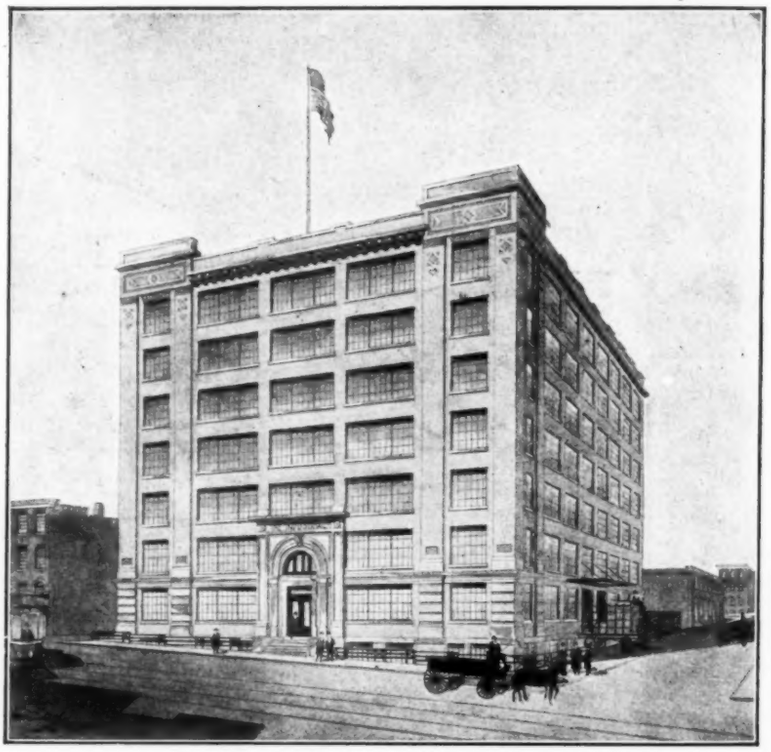
Acting upon the suggestion of J. E. Aldred, president of the Consolidated Gas, Electric Light & Power Company, and president of the Pennsylvania Water & Power Company, a large number of the leading business men of Baltimore have formed a company for the purpose of erecting a building to provide first-class facilities for small manufacturers. The company is known as the Industrial Building Company of Baltimore, and the building which is now under construction will be known as the Industrial Building. It will be a concrete structure with seven stories and basement and a steel frame. Each floor contains about 15,000 square feet of rentable floor space. The building is 151 by 128 feet and U-shaped.

The demand for such a building and its evident value to the community prompted Mr. Aldred's suggestion, which was first made at a meeting of the board of directors of the Consolidated Gas, Electric Light & Power Company. The suggestion was heartily indorsed by the press, and a committee of twenty-four business men was formed. This committee included three representatives from the seven leading commercial organizations of the city and three from the light and power companies. The suggestion was laid before this committee by Mr. Aldred, who stated that the Consolidated Gas, Electric Light & Power Company and the Pennsylvania Water & Power Company would guarantee one-half of the stock.

Prompt action followed. The committee made a tour of inspection of cities where similar buildings are in operation, a site was selected and an option secured. P. O. Keilholtz, consulting engineer, was engaged to design the building, and the finance committee, of which Henry F. Baker, president of the Merchants' & Manufacturers' Association, was chairman, offered to the people of Baltimore 3,000 shares of stock at par value of $100 each. There is but one class of stock, all of which was sold at par, and there was no bond issue. It is interesting to note the wide distribution of the stock as is evident by the fact that in addition to the light and power companies there are 183 stockholders.

The officers of the Industrial Building Company are: president, Alexander Harvey; vice-president, William J. Chapman; secretary and treasurer, Charles M. Cohn, vice-president of the Consolidated Gas, Electric Light & Power Company.

The Industrial Building Company has issued a booklet setting forth the theory on which the building was erected, from which the following extracts are quoted.



THE INDUSTRIAL BUILDING, BALTIMORE.

FACILITIES FOR MANUFACTURING WITHOUT CAPITAL EXPENDITURE.

Capital expenditure is the great obstacle between the small manufacturer and success. To remove this obstacle is the purpose of The Industrial Building, which will be ready for tenants January 1, 1912. The Industrial Building will provide every facility requisite to low-cost production. It offers cheap power, abundant light, absolute fire protection, low insurance rates, efficient elevator and transportation service and safe and healthful surroundings for operatives. Without capital expenditure it will provide for the small manufacturer every essential factory requirement that can be obtained by established industries.

FINANCIAL ADVANTAGES ENJOYED BY THE TENANTS OF THE INDUSTRIAL BUILDING.

Without capital expenditure for land, building, elevator service, power and heating plant, the manufacturer located in The Industrial Building is in a position to employ all of his capital for operating and extending his business. The manufacturer located in The Industrial Building establishes a better credit by virtue of the fact that all his capital is invested in liquid assets. Every factory requirement save the raw material and the machinery will be furnished by The Industrial Building Company.

The question of taxes for land, building and equipment is eliminated for the tenant of The Industrial Building. Under the plant exemption law of Maryland, machinery used for manufacturing is not taxable.

Tenants of The Industrial Building will obtain low insurance rates because of the fireproof construction of the building, which will be "sprinkled" risk. The manufacturer located in the sanitary and comfortable Industrial Building, situated near a large residential section, will enjoy an advantage in the employment of labor.

CHEAP POWER.

By contracting with the central station for all electric power used in the building, The Industrial Building Company will obtain wholesale rates, by which every tenant will benefit. The rates for electric power in Baltimore are the lowest on the Atlantic seaboard and the tenant of The Industrial Building will be in a position to obtain the most advantageous rate by buying power in bulk with the other occupants of the building. There has been developed for Baltimore a tremendous source of electric energy. Power is obtained from three independent sources, the 100,000-horsepower development on the Susquehanna River and two gigantic steam generating stations. Storage batteries and an unexcelled distribution system assure adequate, efficient, never-failing service. The ceilings

of The Industrial Building are provided with sockets to allow the ready attachment of hangers for shafting or motors, thus avoiding considerable expense on the part of the tenant for this mechanical arrangement.

THE ECONOMIC ADVANTAGES OF SANITARY PRODUCTION.

Every successful manufacturer knows the advantages of sanitary factory surroundings. Labor is more efficient, from the fact that it is more contented, and not only is the quality of the product improved but the quantity of the output increased when a factory enjoys the advantage of abundant light, air, and clean, healthful surroundings. The Industrial Building offers the small manufacturer every advantage in this regard that may be obtained by the most successful manufacturer. It puts him on a basis on which he can successfully compete without the necessity of large capital expenditure.

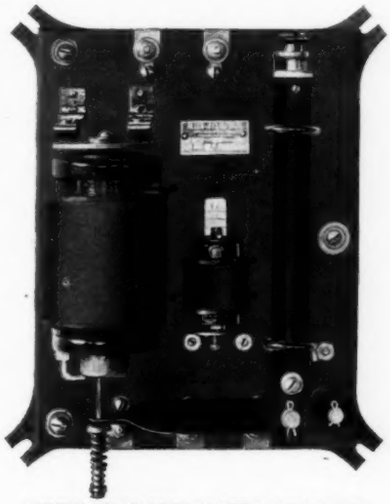
In placing contracts for material necessary for the construction of the building nothing which will burn was bought. The site is exceptionally free from external fire hazard. Abundant air and sunshine are provided, fifty-five per cent of the wall surface being window space in order that all the natural advantages of the site, which has light on all sides, may be enjoyed.

A central transportation system by which freight is delivered and called for, will relieve the manufacturer of the cost of teams or power wagons, their maintenance and operation. Bills of lading and memoranda of shipments will be made out by the clerical force of the Industrial Building Company, and freight and express charges will be prepaid and settled at regular periods.

New Direct-Current Motor Starters.

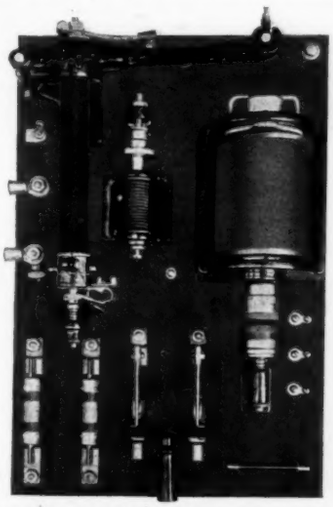
The Allen-Bradley Company of Milwaukee, Wis., has placed upon the market a new line of direct-current electric motor starters, to be used for automatically starting shunt, series and compound motors. They are especially adapted for starting motors under heavy load. Simplicity, durability, reliability and compactness are evident features of this machine. The motor is started by simply closing the line switch and the starter will automatically accelerate the motor to full speed. The operator is not called upon to exercise either skill or judgment, even when the motor is started under a very heavy load. For this reason these starters are very desirable when ignorant help must be relied upon to start motors.

These devices are of the Allen-Bradley carbon compression type, the resistance being secured through the imperfect contact between the surface of prepared graphite disks, piled in a column. This contact resistance varies with pressure, and the resistance changes are caused by subjecting the column to various degrees of pressure. The columns of disks are inclosed within an insulated steel tube, which is provided with suitable terminals and plungers for



ALLEN-BRADLEY MOTOR STARTER.

transmitting the pressure to the disks. Such inclosed columns constitute a complete resistance unit. These graphite disks are well adapted for rheostatic service, as they will not crush or break, are not affected by any temperature that they have to encounter, cannot be



ALLEN-BRADLEY MOTOR STARTER.

fused, will not corrode, and are not changed materially by years of service.

The operation of this machine is as follows: When the main switch is closed, the motor circuit is made through the fuses, resistance unit, current relay and the motor armature. At the same time the solenoid circuit is closed (this is connected directly across the line, and takes a current which is a small fraction of one ampere) and the plunger of the solenoid is drawn up, which produces a pressure on the resistance unit and increases the current in the motor circuit to the predetermined value at which the current relay is set. When this value is reached the current relay operates and opens the solenoid circuit, which reduces the magnetic pull and allows the solenoid plunger to drop back slightly. This action increases the resistance in the motor circuit, which decreases the current sufficiently to allow the relay to close again. Similar cycles of operation are repeated as the motor accelerates, and each time the plunger is drawn a little further into the solenoid, until the short-circuiting contacts on the top are pushed together, which short-circuits the current relay and resistance unit, making them inoperative, and completing the operation of starting the motor.

It will be noted that in starting the motor with this device the current is always held down to a certain predetermined value, and it is impossible to overload the motor by too rapid starting. The current relay is calibrated in amperes, and may be set to suit existing conditions.

Killing Insects by Electricity.

Electricity as an agency to destroy the codling moth is the latest innovation of modern apple-orcharding in the Spokane valley, where W. M. Frost, inventor of the device, and J. C. Lawrence, a practical grower of Spokane, made a demonstration on the evening of August 18.

The apparatus consists of a storage battery to operate incandescent lamps of six candlepower in globes, which are netted with fine steel wires. Attracted by the bright light in the tree, to which the globe is strung, the moth flies against the net work, completes the electric circuit and is instantly killed, the body dropping into a receptacle beneath the globe. Mr. Frost thinks that one apparatus to an acre of trees will keep the moths under control, thus eliminating spraying and saving many dollars for equipment and fluid.

If central-station service is extended to the orchard tracts, as they are in the Spokane valley, the expense of batteries may be saved by making direct connection and using the commercial current. The cost of covering the globes with wire nets is a small item.

Electrically Driven Bloom Shears.

Electrically driven bloom shears have been supplied to several European works. One machine of this kind is capable of cutting blooms 5.9 by 7.5 inches, while a similar machine is built for cutting blooms of 6.5 inches square, cold, or 10.25 inches square, hot. The shearing pressure of this machine is equal to forty-five kilos per square millimeter, and exerts a total force of 1,300 tons.

The slide is balanced by carefully set springs, which insure smooth working and absence of shock. The blades make twelve strokes per minute. The slide is also arranged with adjustable guides, so that wear can be taken. The machine is driven direct by a ninety-horsepower electric motor through a rawhide pinion. To protect the motor against shock a patent elastic clutch is provided. The machine has a height of 14.76 feet, and covers a floor space of 14.75 by 16.14 feet, its total weight being about fifty-five tons.

Two flywheels are fitted, of a weight of three tons each, keyed to a shaft of forged nickel-steel, the shaft running in gun-metal bearings with ring lubricators. The large spur wheel has a diameter of 10.17 feet, and a weight of six tons, and the cam shaft has a weight of about 2.5 tons, with a diameter of eighteen inches. The body of the machine, the slide, the slide-cover, as well as all gear wheels, are made of the best open-hearth cast steel. The shafts and pinions are made of best forged steel.

A holding-down attachment is placed in front of the blades, which can easily be raised or lowered to insure a flat cut and to preserve the blades.

In front of the blades is a set of electrically driven live rollers which automatically bring the blooms to the blades. These rollers are built into a self-contained carriage, the frame of which is made of cast steel. This carriage runs on rails, and can be removed if not wanted.

In order to prevent damage to the machine by overstrain, the driving shaft is fitted with a safety clutch, which gives way should blooms of dimensions exceeding the capacity of the tool be put through the blades. The starting is effected by a clutch coupling, operated by a hand lever, but the stopping is done automatically when the slide reaches the highest position. This construction avoids the risk of making a false cut, and is safe for the workman, besides allowing him the free use of both hands; if desired, however, the work may be continuous.

This machine was built by the Stahlwerk Oeking Aktien Gesellschaft, Düsseldorf, Germany.

An Electric Hot-Air Douche.

Electrically operated devices are largely employed by German physicians for providing a hot-air douche in the treatment of lumbago, rheumatism and other similar disorders. The accompanying illustration shows a unique form of hot-air douche made at Berlin, Germany, consisting of a portable electric fan motor combined with an electric heater so arranged as to provide a blast of hot air of 100 degrees centigrade or at a higher temperature if desired. It is operated from an ordinary electric-lamp socket and the amount of heat varies according to the speed at which the blower is driven and the current utilized in the heating unit.

ELECTRIC HOT-AIR DOUCHE.

The motor is very light and of compact construction, the blast of cold air entering the device tending to keep the motor cool. The heated air passes over the resistance conductors and is projected in a blast from one or two tubes.

Nickel Plate Railroad Extends Telephone Train Dispatching.

The Nickel Plate has recently ordered of the Western Electric Company a complete telephone train-dispatching circuit, consisting of thirty-one Western Electric selectors and the necessary telephone equipment, to equip its Buffalo Division. This circuit will be 116 miles in length, and will extend from Buffalo, New York, to Conneaut, Ohio. The train dispatcher will be located at Conneaut.

Cooper Hewitt Silica Lamps.

The Westinghouse Cooper Hewitt Company, Limited, of Holborn Circus, London, has recently put upon the market a new type of silica lamp for direct current, taking only 1.5 amperes at 200 to 250 volts, and giving, it is stated, 800 candlepower. The light is obtained from the incandescence of mercury vapor in a short tube of transparent quartz. This tube (called the "burner" for convenience by the makers) is provided with two electrodes of mercury, and is exhausted to a high degree of vacuum. The lamp is started by the tilting of the burner by an electromagnet, which is automatically cut out of circuit as soon as the lamp lights up, and allows the burner to fall back to its normal position by gravitation.

At first the color of the light emitted is blue, but after a very short time, owing to the high temperature of the quartz, the light becomes whiter. This allows of clear or very slightly opal glass globes being used. The lamp is self contained, and totally inclosed, and the makers recommend it for use in places where inclosed carbon arcs are at present employed. It will stand fluctuations of voltage ten per cent above or below the normal without giving any trouble. It is said that the life of the burner is, on an average, between 2,000 and 3,000 hours, and a minimum of 1,000 hours is guaranteed. About 260 of these lamps have been installed in Messrs. Vickers' works in Sheffield, and many other firms are using them throughout Great Britain.

Underground Lines for Indianapolis.

As the result of an order of the Board of Public Works of Indianapolis, the Postal Telegraph Company will be compelled to run its city lines in underground conduits.

It is estimated that the cost of doing the necessary work will be $25,000. A contract for the installation has been awarded to G. M. Gest & Company, of New York and Cincinnati.

Switchboard Demand Heavy.

The Westinghouse Electric & Manufacturing Company's switchboard shop broke a record last month, turning out 800 panel switchboards. The previous high record was during June of this year, when 751 panels were turned out. The company desires to have a capacity of 1,000 panels per month.

Current Electrical News

CANADA.

(Special Correspondence.)

OTTAWA, ONT., SEPTEMBER 1.—To show the Canadian farmer how to farm with electricity, after the manner of the European farmer, is the plan of the Ontario Hydro-Electric Commission. The chairman of the Commission states that the farmer in Ontario will be taught to utilize the power available at Niagara, and so find for himself a solution of the labor question.

The provincial government of Quebec has adopted a new policy as to water powers belonging to the Crown. In future, no water power will be definitely sold. Twenty years ago, these water powers were allotted for nothing. Ten years ago, much water power, such as the Shawinigan Falls and Grand Mere Falls, were sold for $50,000, now the water powers will be only leased for long periods up to ninety-nine years.

The Sherbrooke Railway & Power Company, of Sherbrooke, Que., has authorized the issue of $300,000 of additional bonds in connection with its recent purchase of the Eastern Townships Electric Company, the Lennoxville Light & Power Company and the Standstead Electric Company, and for the extending the distributing systems of these companies. By their acquisition, the Sherbrooke Company controls the major part of the electric lighting and power business in the rich and thickly populated district lying between the city of Sherbrooke and the United States border.

By the first of October next, the Shawinigan Water & Power Company, of Shawinigan Falls, Que., will be delivering power in the city of Montreal, over eighty miles distant, through its own transmission lines and over its own right of way. The company will have a capacity of 25,000 horsepower with an overload capacity of 50,000 horsepower, and in an emergency could deliver 100,000 horsepower. A contract has been made with the Montreal Light, Heat & Power Company, to sell the latter concern an additional 40,000 horsepower, in addition to the 23,000 horsepower taken by that company now. The new development of power at the Shawinigan plant is known as the second development. It is expected that, in time, all the power delivered by the company in Montreal will be drawn from this second development, which will generate sixty-cycle current, that being the frequency most used in Montreal. The new plants will be capable of ultimately producing 75,000 horsepower, which with the 55,000 horsepower already generated, will eventually give a total installed capacity of 130,000 horsepower.

An electrical thermometer, which it is believed will be capable of foretelling, on ocean-going vessels, the approach of icebergs, is to be tested by the Department of Marine here. If successful, the invention will be one of the most important in years to the shipping interests of the world. The problem of foretelling when a vessel is approaching an iceberg, is one that has been studied by navigators for years, but nothing approaching a solution of it has, up to the present time, been discovered. Professor Barnes, of McGill University, Montreal, is the man who seems to have solved the problem. He has, for years, been making a study of one of the least known branches of scientific research—the laws governing the formation of ice. It was in connection with this research work that Professor Barnes devised the instrument that promises to be such a help to navigators the world over. It is an electric thermometer, built along different lines to that use in laboratories, of which, however, it is an adaptation. In brief, he has prepared an electrical recording apparatus which registers the changes in the amount of current passing through the circuit of which it is a part. So sensitive is the action, that the slightest change in temperature will cause an increase or decrease in the flow of electricity through the conducting wire. A section of the circuit mentioned is enclosed in a small cylinder, which is attached to the end of a pole. This pole is sunk in the water while the vessel is going at full speed, and the electrical recording apparatus does the rest. It is very easy to reduce the curve, made by the apparatus, into terms of temperature, and so delicate is the instrument, that it will record the changes to the thousandth part of a degree. Professor Barnes has fully tested the apparatus in making his tests of the temperature of the currents in the St. Lawrence river.

Construction is well advanced at Jordan River, forty-five miles from Victoria, of an electric power plant capable of developing 10,000 horsepower, in which enterprise an expenditure of $1,250,000 is involved. The power developed will be transmitted to Victoria and utilized in supplying light and power generally and in the operation of the Victoria city and suburban street railway services and a new electrical line connecting Victoria with various portions of the Saanich Peninsula. Another larger power project is in development, the purpose of the promoters being to harness and market the power of Campbell River Falls for use in the operation of logging roads. From these falls experts have reported 60,000 horsepower can be developed.

MEXICO.

(Special Correspondence.)

MEXICO CITY, MEX., AUGUST 26.—Electricity is playing an important part in the construction of one of the longest mining tunnels in the world in the vicinity of Pachuca. This great work is known as the Nepton tunnel and when finished it will be a little over six miles long. It is being constructed by Gabriel Mancera, an engineer of this city. He has installed near the mouth of the tunnel an electric power plant for supplying energy for drilling and also provides the lighting system and gives the power for operating ventilating fans. One of the remarkable features of this tunnel is that it will traverse the underground mineral region at a depth of about 1,400 feet below the surface of the city of Puebla. It was started eighteen years ago and there has been finished up to this time about two miles of the work. Its special object is to drain the whole Pachuca mining district and to afford an outlet for the ores of the different mines with which it will connect. An electric tramway system will be installed in the tunnel when the work has made a little further progress.

The recently issued annual report of the Mexico Tramways Company, which operates the Mexico City lines, shows that its car mileage during the year 1910 was about 12,800,000. The average number of eighteen-hour cars operated per day during 1910 was 253, compared with 235 in the year previous. The average earnings per passenger-car per day were a little more than $57.00, and average passenger receipts per car-mile for 1910 were $44.98. These figures represent substantial improvement over the year previous.

It is interesting to note the rapid growth in the electric service of the company and the consequent diminution of the mule and steam car mileage service during the past six years. In 1905 the total mileage operated by electricity was below 100, which compared with nearly 159 miles at the close of 1910. The mileage of tracks operated by mules in 1905 was about 39, compared with 21.25 in 1910, and the steam mileage in 1905 was 12.25, compared with nothing in 1910. The mileage of the company's electric, mule and steam lines since 1904 compares as follows:

	Electric	Mule	Steam	Total
1910	158.62	21.31	....	179.93
1909	145.24	26.65	....	171.90
1908	125.41	37.88	7.88	171.17
1907	118	37	12	167
1906	108	39	12	159
1905	98.47	39.16	12.33	149.96

A deal involving the control of 350,000 acres of land has been closed, in which a syndicate headed by Dr. F. S. Pearson will construct dams in three Texas rivers—the Guadualupe, the Frio and the Nueces—and also build irrigating plants and canals for watering more than 500,000 acres.

This project is in addition to the $2,000,000 Medina River dam and irrigation deal of recent consummation. They will represent an investment of nearly $15,000,000. The land is in Uvalde, Nueces, Frio, Edwards, Kinney, Lasalle and other counties of west Texas.

COMMISSION NEWS FROM NEW YORK

(Special Correspondence.)

The Public Service Commission, Second District, has been requested by the municipal authorities of the village of Catskill to fix the price to be paid for street lighting, under a new contract proposed to be entered into with the Schoharie Light & Power Company, the parties having been unable to reach an agreement. The Board of Trustees of the village submitted several lighting specifications to the company and is particularly desirous of securing reasonable rates upon thirty-five 200-watt lamps, fifty sixty-watt lamps and 200 forty-watt lamps. This plan contemplates the elimination of all arc lamps now used, with the consequent saving in cost of maintenance and without any necessity of a change in station apparatus. The company has offered to light the streets of the village all night and every night as proposed in this plan, for the period from the termination of the present contract to May 28, 1912, at the annual rate of $53.78 for the 200-watt lamps, $22.50 for the sixty-watt lamps and $20 for the forty-watt lamps. These prices, the village believes to be excessive and unreasonable and in turn has offered to the company a compromised price of 6.25 cents per kilowatt-hour for such service. The company refuses to accept the compromise. The village authorities, therefore, appeal to the Commission to adjust the difficulty, and the Commission is asked to request the company to continue furnishing lights to the village under the same hour schedule and at the same price as at present until the matter is heard and determined.

The Public Service Commission, has instructed its Counsel to commence actions to recover a penalty provided by law against twenty-two gas and electrical corporations for failure to file the annual report required by the Commission, for the year ended December

31, 1910. The companies were given until February 15 to file these reports, and repeated requests for reports from the statistician of the Commission and its counsel since that time have been unavailing.

The Commission has ordered all public service corporations within its jurisdiction, maintaining poles or other structures for carrying overhead wires, to stencil or mark such poles with the initials of the owner and with a number whereby the location of any pole may be identified. Investigations made by inspectors of the Commission show a general lack of such stenciling throughout the state, which is necessary for identification of poles as to ownership and location, in the inspection of construction, in service complaints and in valuation proceedings.

The Public Service Commission, First District, has made public a report showing progress of construction work on Brooklyn Fourth Avenue subway. Report shows that 1,400,000 cubic yards or eighty per cent of entire excavation has been done. Approximately five-eighths of contract value has been prepared to date. There are six contracts, price of which aggregates $15,886,381. Total working force engaged on all contracts now numbers about 3,500 men.

The Public Service Commission, First District, on August 29, began advertising for bids to make borings along the lines of extension proposed by the Interborough Rapid Transit Transit Company and other routes. Bids will be received at the office of the Commission until noon Tuesday, September 12, when they will be opened in public by the Commission. Awards of contracts to the successful bidders will follow within a day or two Borings are required in advance of the making of plans for the new subways and river tunnels, so that the engineers of the Commission may design a structure suitable to the character of the ground through which it is to pass. These borings are also required by bidders in making their estimates for construction, as they show the character of the soil through which the excavation is to be made. Borings are now called for to be made at a number of points in Manhattan and Brooklyn. Should the results of boring at any point indicate the advisability of changing the line, the proposed tunnel borings along that line may be abandoned and borings made along such other lines as may be determined upon. Each bid must be accompanied by a certified check for $1,000 and when the contract is let the contractor will be required to furnish bonds in the sum of $10,000.

LIGHTING AND POWER.

(Special Correspondence.)

ABERDEEN, WASH.—The installation of a municipal electric light plant is being agitated. C.

MIAMI, ARIZ.—The Summit Copper Company will build an electric light and power plant. A.

PLYMOUTH, WIS.—The Water & Light Commission has recommended a new electric light plant.

DEER RIVER, MINN.—The Everton Light & Power Company is erecting a large electric light plant. C.

DEL RIO, TEX.—The Del Rio electric light and ice plant has been sold to W. R. Payne for $37,550.

STOCKDALE, TEX.—The Stockdale Cottonseed Oil Mill Company is installing an electric light plant.

STANTON, MICH.—Bonds for $10,000 for a municipal electric light plant and water works have been voted. C.

SIOUX FALLS, S. D.—The H. M. Byllesby Company will extend its electric light lines to the McKennan Hospital. C.

PENTLAND, CAL.—The San Joaquin Light & Power Company has purchased a site here for the erection of a new building. A.

CANBY, MINN.—The Citizens Electric Light & Power Company will expend $25,000 on the installation of an electric light plant. C.

BAKERSFIELD, CAL.—The Kern River Oil Fields, Ltd., plan to install electric motors for oil-drilling operation in the near future. A.

WHITE BLUFFS, WASH.—The Pacific Power & Light Company has asked franchises for electric lighting at this place and Benton City. A.

SALEM, ORE.—The Portland (Ore.) Railway, Light & Power Company contemplates the installation of a cluster street lighting system here. A.

BURNS, ORE.—James D. Fellows has been granted a twenty-five-year light and power franchise, and will install an electric power plant. A.

SYLVAN GROVE, KANS.—Work has been started on the water-works and electric light plants here. Bonds to the amount of $25,000 were voted.

NORTH SAN JUAN, CAL.—The Northern Water & Power Company plans for the erection of a hydroelectric power plant at French Corral, near here. A.

OGDEN, UTAH.—The Merchants' Light & Power Company recently turned on power from its new plant, supplying lighting for the main streets of the city.

SPOKANE, WASH.—The Burlington Mining Company has commenced the erection of a power plant for mines operation on its property near Wallace, Ida. A.

PAXTON, ILL.—Paxton is to construct a $17,000 electric light plant, having authorized the issuance of bonds for its construction and the purchase of machinery.

MEDFORD, ORE.—The Siskiyou Electric Power & Light Com-Waterloo, Ind., thus connecting with the Toledo & Chicago, an interurban road projected several years ago. H.

NEW SHARON, IOWA.—The construction of a high-tension transmission line for electric light to Oskaloosa is projected by the Oskaloosa Traction & Light Company. C.

JANESVILLE, MINN.—The Consumers' Power Company, Mankato, Minn., is planning to supply this town with light from Mankato, and also Eagle Lake and Waseca. C.

LACLEDE, MO.—The Laclede Electric Light Company has been incorporated with a capital stock of $5,000. The incorporators are: Z. T. Stanley, E. R. Allen and R. L. Wheeler.

FRESNO, CAL.—The San Joaquin Light & Power Company will make improvements and additions to its private telephone system between here and Bakersfield to cost $18,000. A.

DUGGER, IND.—The Town Board has granted a franchise to the Sullivan County Electric Company to erect, equip and operate a plant to furnish the town with light and power. S.

STOCKTON, CAL.—Bids for furnishing an underground conduit lighting system, with electroliers throughout the business portion of the city, have been called for by the City Council.

OAKLAND CITY, IND.—Plans have been approved for the construction and equipment of a central lighting and heating plant to supply the buildings of the Oakland City College. S.

BOSTON, MASS.—The New England Water Power Company has been incorporated with a capital of $1,500,000. The company proposes to develop hydroelectric power on the Deerfield River.

GETTYSBURG, PA.—The Peoples Light Company is in the course of formation here. The new company will, it is said, establish low rates and will extend its service to nearby towns.

ASHTABULA, O.—The Home Power Company has been incorporated with a capital of $60,000. Directors are: H. Beides, B. B. Seymour, R. R. Watson, F. A. Macon, and Matt S. Spaulding.

WASHOUGAL, WASH.—Sam Sampson has made application for a franchise to extend his high-voltage transmission line through this town and county to Vancouver, a distance of sixty miles.

TOMBSTONE, ARIZ.—The Western Mines & Development Company, operating the Towner-Lovel mines, is planning for the erection of an electric power plant. Frank Dean is chief engineer. A.

EL PASO, TEX.—An electric lighting system is being installed at Fort Bliss, by the F. E. Newberry Electric Company, of St. Louis. The plant will cost about $30,000. Tungsten lamps are to be used.

POTTSVILLE, PA.—The borough electric light plant at Shickshinny has been bought by the Luzerne Gas & Electric Company which controls the Hazleton gas plant. The price paid was $100,000.

MONETT, MO.—Plans and specifications submitted by Roland & Westover for a new light and power plant have been accepted by the City Council. The plant will be completed in about four months.

COLTON, CAL.—The Southern California Edison Company has awarded the contract for the erection of its new substation here to the F. O. Engstrum Company, of Los Angeles. The price is $16,000. A.

FARGO, N. D.—The Northwood Mill & Light Company has been incorporated with a capital of $25,000 by David D. Hiebert of Harvey, Otto O. Restodius of East Grand Forks and Otto Sangstad of Northwood.

DURANGO, COLO.—The San Juan Water & Power Company will soon extend its service to Creede. Power will be used for lighting and for work in connection with the various mining companies near Creede.

RANDLE, WASH.—The Valley Improvement Company of Portland, Ore., will soon commence construction of its proposed power plant near here. Plant and transmission system are estimated to cost $15,000,000. A.

GIBSON, ILL.—The Central Light, Heat & Power Company has incorporated with a capital of $100,000, to own and operate an electric light plant. The incorporators are Archie Hood, H. L. Clarke, and James Hood.

LOS ANGELES, CAL.—A complete power and electric lighting plant will be installed in the thirteen-story office building to be erected on Broadway by the Los Angeles Investment Company. Estimated cost of building, $1,000,000. A.

SACRAMENTO, CAL.—The design for the electrolier system as proposed by the Retail Merchants' Association for certain streets and alleys of this city, has been adopted by the Board of Trustees and will be installed in a short time.

OGDEN, UTAH.—Work on the Davis & Weber Counties Canal Company's hydroelectric power plant at Riverdale will be started as soon as contracts can be awarded. The company has asked for bids on the construction of the plant.

SCRANTON, PA.—An isolated electric plant will be installed in the Globe Warehouse here. The plant will supply sufficient current for 200 arc lights and an equal number of incandescent lamps, and will also supply power for motors.

CLARION, IOWA.—Plans have been completed for the new electric light building for Mozingo & Mack to replace the building burned August 4. The work will be pushed rapidly and it is expected that the city will have lights again very soon.

NEWARK, O.—The Licking Light & Power Company plant here has been purchased by the American Gas & Electric Company. H. L. Montgomery of Auburn, N. Y., will be the new manager. The plant will be enlarged and generally improved. H.

WORTHINGTON, IND.—William H. Yule, of Hartford City, has urchased the Indiana Water & Light Company's plant at this place and is now in charge. It is understood the new owner will install considerable new machinery and equipment. S.

LYLE, WASH.—The Northwestern Electric Company of Portland has acquired twelve miles of water rights on the Klickitat River, near here, from Ham, Yearsley & Ryrie, for $75,000, and contemplates extensive hydroelectric power development. A.

HUMBOLDT, IOWA.—The Northern Iowa Light & Power Company is putting in a second and larger dam at its power site near this city. The Fort Dodge construction work has not begun in earnest and will not begin until the dams are completed here.

BROKEN BOW, NEBR.—The Custer Electric Company is erecting an office building adjoining the light plant. Although the company has only been in business a few months the growth has been such that twenty-four-hour service is promised within a year.

COLUSA, CAL.—The Northern California Power Company has been granted a franchise for a power and light system in the town of Williams and expects to have it in working order in a few weeks. Jerry Myers, of Willows, will be manager of the Williams office.

BEECHER, ILL.—The Beecher Light & Power Company has been incorporated with a capital of $6,000 by a number of local men. The officers are: Herman Ruge, president; Thomas Clark, vice-president; William J. Henze, secretary; George Batterman, treasurer.

SAN FRANCISCO, CAL.—The Placer Electric Power Company has been incorporated by R. K. Borland, F. A. Nightingill and S. T. Harding with a capital stock of $2,000,000. The company plans for the erection of power plants in mining districts to supply power for mines operation. A.

RICHMOND, IND.—Before granting the Richmond Water Works Company a new franchise the City Council has demanded the company to surrender its books for examination. The Council wishes to know what profit the company has been making to govern it in the question of rates. S.

FULLERTON, CAL.—The Southern California Edison Company has agreed to install and maintain an improved street-lighting system of, five 500-watt tungstens, five 250-watt tungstens, in the business district, and forty-five fifty-watt tungstens, in the residence section, for $98.75 per month. A.

NORWICH, CONN.—The new 750-kilowatt generator of the local power and lighting company was recently put in operation. The demand for power has increased so much that this addition became necessary, and it is probable that another turbine of the same size will be installed in the spring.

LOS ANGELES, CAL.—The Union Oil Company has awarded the contract for the installation of a power and generating plant in its new thirteen-story office building to the John W. Catron Company, Los Angeles. The contract price was $11,325 and the time limit placed is November 1, 1911.

ELEPHANT BUTTE, NEW MEX.—Work is now in progress erecting the building for the electric power plant that is to be installed by the Federal Government at the site of the proposed dam here. The machinery will cost about $100,000. William C. Beatty is superintendent of construction. D.

INDIANAPOLIS, IND.—Articles of incorporation have been filed with the Secretary of State by the Auto Lighting & Electric Company. The company proposes to establish a plant to manufacture electric vehicle lights and other electrical devices. F. C. Parker, C. R. Brown and G. S. Monfort are directors. S.

PHOENIX, ARIZ.—The City Council has awarded a contract to the New State Electric Company, Phoenix, for the installation of an ornamental street-lighting system in its recently paved business district. The price is stated to be about $20,000. Iron posts and incandescent lamps, four fixtures to the block, will be used. A.

MILWAUKEE, WIS.—The new repair shops of the Milwaukee Electric Railway & Light Company, between Thirty-eighth and Forty-first Streets, will be finished about October 1. They have been in process of construction for the past eighteen months. They cover about twenty acres of ground, and will cost about $500,000.

PORTLAND, ORE.—The Portland Railway, Light & Power Company will soon commence construction of a dam near Cazadero, on the Upper Clackamas River for its proposed power plant. A dam is now being constructed at Oak Grove on the Clackamas River, where a power plant of 25,000-horsepower capacity will be erected.

TOWER, MINN.—The City Council has let contracts for the building of a power plant and transmission line. The plant is to be at Pike River Falls, six miles from town. The transmission line will probably be a submerged cable laid down Pike River to Pike bay, an arm of Lake Vermilion, through Pike bay and up the East Two Rivers to the city. It is expected the plant will be ready for operation by November 1.

TWIN BRIDGES, MONT.—Surveys are being made from Ruby for a power line to be constructed by the Madison River Power Company, for the purpose of furnishing electric lights in the towns of Laurin, Sheridan and this place. It is understood that the work of constructing the line will be commenced as soon as the right of way is secured.

CANON CITY, COLO.—It is reported that H. M. Byllesby & Company, of Chicago, have secured options on the holdings of the Colorado Light & Power Company here. The Canon City Company supplies the Cripple Creek district and the towns of Canon City, Florence, Concrete, Williamsburg and other coal camps in this county with power.

WILMINGTON, DEL.—Due to the expansion in its business, the Electric Hose & Rubber Company has found it necessary to replace the engines which it has been using with 800 horsepower motors. For this reason the power lines of the Wilmington & Philadelphia Traction Company in that vicinity are being rebuilt. The work will cost about $10,000.

KEENE, N. H.—The Keene Gas & Electric Company has awarded the contract for building its new power line from Hinsdale to Keene to the Archibald-Brady Company, of New York. The contract calls for the completion of the work November 10. The new lines will be supported entirely on iron towers and will transmit at 6,600 volts from the Hinsdale dam.

DORRIS, CAL.—A survey of the projected lines for the Siskiyou Electric Light & Power Company has just been completed, and the wire will be strung in a short time. Dorris will be the distributing station for Macdoel and two large ranches owned by the Churchill Company, of Yreka. It is expected that power will be supplied within a few weeks.

PHOENIX, ARIZ.—The S. Morgan Smith Company, York, Pa., has been awarded a contract for machinery for the new 1,000-horsepower electric plant at Arizona Canal Falls. The Reclamation Service is in charge of the work, the cost being borne by the Salt River Valley Water Users' Association. A 6,000-horsepower plant is planned on the Salt River, near Tempe. A.

NESS CITY, KANS.—Bonds to the amount of $16,000 have been voted for the purpose of rebuilding the electric light plant which was destroyed by fire in June. Contracts will be let at once for the erection of a suitable building and the installing of the necessary machinery. The poles and wire now standing, and owned by the old company, will in all probability be purchased by the city.

ELY, NEV.—An immense electric power plant is soon to be erected on Cleve Creek by the Telluride Power Company, according to plans recently made public. Cleve Creek, on which it is planned to erect the new plant, is one of the largest in Eastern Nevada. It is estimated that it will develop more than 3,000 horsepower. The plant will be used in furnishing electric light and power to Ely and surrounding camps.

MARYVILLE, TENN.—The Maryville Electric Light, Heat & Power company, has been formed here with a capital stock of $100,000. The incorporators are: I. B. Zeigler, John M. Clark and James A. Goddard, of Maryville, and J. G. and William Sterchi, of Knoxville. It is the purpose of the promoters to erect a large generating plant at Abram's Falls on Abram's Creek in this county, at a distance of twenty-five miles from Maryville, and transmit electricity to Maryville and other cities.

NOBLESVILLE, IND.—The White River Light & Power Company's hydraulic plant recently sold at receiver's sale for $30,000 has been acquired by Alexander Holiday of the Noblesville Heat, Light & Power Company and the Indianapolis Water Company. The new owners have made no statement relative to completing and operating the plant. It is believed that the Indianapolis Water Company expects eventually to draw a part of its water supply from the reservoir at the Noblesville dam. S.

MINNEAPOLIS, MINN.—It has been decided to install an electric light plant at the city garbage crematory. The plant, including engine, lamps, dynamo and pole lines, will cost between $42,000 and $43,000, according to the bids received by the City Council. This will cover the entire expense except the cost of enlarging the crematory to provide additional space. The electric plant is designed not only to light the workhouse, Hopewell Hospital and the crematory, but to provide power for about two hundred street lights for Camden Place and North Minneapolis.

HARRISBURG, PA.—Three charters have been granted by the State Department, as follows: Conewago Township Electric Light, Heat & Power Company, capital stock, $5,000; McSherrystown Electric Light, Heat & Power Company, capital stock, $5,000; New Oxford Electric Light, Heat & Power Company, capital stock, $5,000. The incorporators of the three companies are Raymond F. Topper, George J. Benner, and Stella I. Raffensberger. The treasurer is Ellis S. Lewis, York. The business of the three companies will be transacted at Gettysburg. The promotors contemplate supplying light, heat and power by means of electricity to the towns of McSherrystown and New Oxford, having already appleid for franchises in those places; also at several places in Conewago township, principal among which are Edgegrove and Mt. Rock.

ELECTRIC RAILWAYS.

(Special Correspondence.)

CHICO, CAL.—George E. Springer has been granted a franchise for an electric street railway in the town of Chico.

PASO ROBLES, CAL.—An electric road through this place, and connecting the San Joaquin Valley with the coast, is being considered.

WATTS, CAL.—The Pacific Electric Railway Company has been granted a fifty-year franchise for a street railway on certain streets of this city.

LOS ANGELES, CAL.—Construction work will be started in a short time on an electric line from Los Angeles to El Segundo, the new Standard Oil town.

LOS ANGELES, CAL.—The Pacific Electric Company has let the contracts for construction of the electric railway line from San Bernardino to Riverside, Cal.

YUBA CITY, CAL.—The Northern Electric Railway plans for the construction of a line from this city to Colusa. A line is also contemplated to Roseville, Cal. A.

PASADENA, CAL.—Work will start at once on the new $10,000 passenger and freight station of the Pacific Electric Company at Mission Street and Fair Oaks Avenue.

SISTERSVILLE, W. VA.—Construction work has been started on the electric line between Middlebourne and this city. Work will be pushed on the tunnel between the two cities.

VANCOUVER, CANADA.—It is announced that the construction will be commenced at once of the proposed extension of the British Columbia Electric Railway from New Westminster to Millside, B. C.

FAYETTEVILLE, ARK.—W. A. Fraser and others, of Dallas, Tex., have been granted a fifty-year street-railway franchise, on condition that they build a line connecting the university and mountain.

MAYSVILLE, KY.—The Maysville Street Railroad & Transfer Company has begun to carry out its enlargements and improvements as planned. As a beginning new car barns are to be built and new cars purchased.

DAKOTA CITY, NEBR.—The Sioux City, Crystal Lake & Homer Railway was recently sold to E. P. Howell, of Sioux City. It is thought that this road will later become part of a line between Omaha and Sioux City.

DUNNIGAN, CAL.—Four lines have been surveyed between Woodland and Dunnigan for the proposed Westside Electric Railroad. From Dunnigan to Red Bluff the lines will parallel the track of the Southern Pacific Railroad.

HARRISBURG, PA.—A charter has been granted to the Lebanon & Campbellstown Street Railway Company to construct a ten mile trolley line in Lebanon County. The capital is $60,000. M. S. Hershey is president of the company.

ST. LOUIS, MO.—The Missouri, Iowa & Minnesota Construction Company is projecting the construction of an electric railroad to Minneapolis. The company will incorporate as the St. Louis & Minneapolis Railroad Company with a capital of $20,000,000. C.

BELLEFONTAINE, O.—Stock of the proposed Wapakoneta, Belle Center & Kenton traction line is selling readily and the project now seems assured. A committee of Wapakoneta business men appointed to dispose of the $200,000 worth of stock assigned to Auglaize County, reports that more than $40,000 has already been disposed of. H.

TIFFIN, O.—Engineers are busily engaged surveying the route of the new Tiffin-Fremont electric railway. Most of the right of way has been secured. Congressman Anderson is prominently connected with the scheme. The contracts call for the commencement of the work within four months and its completion within ten months. H.

LAPORTE, IND.—According to reports C. H. Geist of Philadelphia, proposes to carry out the plans of the promoters and builders of the Chicago-NewYork Air Line and build the road from Laporte east to Goshen, tapping South Bend in route. At present the Air Line cars are running to the station of the Northern Indiana Railway. S.

WATERTOWN, S. D.—A franchise has been granted to Ferris Brothers for a period of twenty years for the operation of a street railway. It is the intention to build the first line directly out to Lake Kampeska, which has become famous as a resort in that section of the state. After that is completed lines will be built about the city as needed.

PORTLAND, ORE.—It is reported that both the Oregon Electric and the Southern Pacific Companies will extend their electric railway lines from Portland to Eugene before the end of the coming year. Plans for the extension of the Oregon Electric Company's line have been completed but no official statement has been made by the Southern Pacific Company.

JOLIET, ILL.—The Chicago, Ottawa & Peoria Railway, which is the northern section of the Illinois Traction System, is rapidly working on the construction of its twenty-three mile line between Morris and Joliet. It is hoped to have this extension completed early in fall. It will make Morris, Ottawa, Streator, La Salle, Princeton and intervening towns directly accessible by electric interurbans from Joliet and Chicago.

EL PASO, TEX.—It is reported that Epes Randolph, vice-president of the Arizona Eastern and Southern Pacific, of Mexico, has purchased the street-car system of Phoenix, Ariz. The reported purchase of the street car system of the capital city is said to be the first step in the installation of electric transmission throughout the Salt River valley and connecting towns in that part of Arizona.

WASHINGTON, PA.—Business men of Pittsburg and Washington are understood to be back of a project to build an interurban road from this place to West Middletown, twelve miles north of here. The surveys have been completed, much of the right of way has been obtained and the money to finance the project fully is said to be in hand. The estimated cost of construction is $250,000.

SAN DIEGO, CAL.—The San Diego, El Cajon & Escondido Railway Company has been incorporated by William Stell and C. O. Nichols of El Cajon, W. L. Ramey and Frank C. O'Kelly of Escondido and G. W. Purcell, H. G. Crowe and C. C. Riordon of San Diego. This company will build a sixty-mile interurban line from San Diego to Escondido via the El Cajon Valley with a branch to Lakeside.

PIERRE, S. D.—Articles of incorporation were filed here recently for the Twentieth Century Transportation Company to construct an electric line from Chicago to Rapid City to cross Illinois, Northeast Iowa, Minnesota and South Dakota by way of Decorah, Minneapolis, Watertown and Pierre. It is capitalized at $1,000,000, the principal office being given as Pierre. Most of the incorporators are at Lancaster, Wisconsin.

DEFIANCE, O.—The Ohio Electric Company has secured an option on a large building at the corner of Auglaize Avenue and Second Street, which will be used as a station for the Defiance-Lima branch. The City Council has extended the time for the company to complete its work until January 1, 1912. The lines which now terminate at the outskirts of the city will be extended as far as the Auglaize River bridge. H.

GARY, IND.—Almost a dozen railroads are building or are preparing to build large yards and establish repair shops in this territory. This move is being made in connection with the plan of all the trunk lines entering Chicago to establish their freight terminals in the Gary region and make Gary the gateway to Chicago. An interesting feature of the plan includes the electrification of the several lines entering Chicago thus making Gary the division line between the steam and electric divisions of the various roads, and eventually establishing a large terminal for steam and electric railroads. S.

CLEVELAND, O.—The Cleveland, Barberton, Coshocton & Zanesville Railway Company has negotiated a bond issue of $2,000,000 and will start active construction work in a short time. The company proposes to build first the section of the line from Cleveland to Orrville, a distance of fifty-two miles. It expects to get a large amount of the work on the section nearest Cleveland completed during the present year and hopes to have a portion of the line in operation during the coming year. J. J. Breitinger is president, W. E. Brooks of Elyria is vice-president, George Hewlett secretary and B. E. Ottman treasurer.

SOUTH BEND, IND.—The officials of the South Bend & Logansport Traction Company announce that work will be resumed on the line from this city to Logansport, at which point connection will be made with the Indiana Union Traction Company for Indianapolis. The grade is completed as far south as Plymouth and the purpose is to extend the line to Logansport as rapidly as possible. The road is being built by South Bend and Philadelphia capitalists. Officers of the company were elected at the recent annual meeting as follows: S. S. Perley, president; Thomas P. Murdock, vice-president and secretary, and Virginius Nicar, treasurer.

EVANSVILLE, IND.—Articles of incorporation have been filed with the Secretary of State by the Evansville, Henderson & Owensboro Railway Company. The capital stock is $10,000 and will be increased later on. This company proposes to finance, construct, equip and operate a street and interurban railroad and plants for the generation and distribution of electricity for heat, light and power. The primary object of the company, however, is to build an interurban road from Evansville to Henderson, install a ferry to convey the cars across the Ohio River, and electrify six miles of the Illinois Central steam line over which the cars will operate. William A. Carson, W. H. McCurdy, Albert F. Karges, Philip Speck, M. S. Sontag and Charles C. Tennis are directors. S.

TOLEDO, O.—Extensive improvements some of which are already under way are being planned by the Toledo & Indiana Railroad which recently was reorganized. The tracks have been rebonded from Toledo to Bryan, and the roadbed is being reballasted with slag and stone, the work to be completed by January 1, 1912. A recently purchased electric locomotive is aiding in the task and when completed will be used exclusively in the handling of heavy freight. The power plant at Stryker has been overhauled, and numerous other expensive improvements are under way. The daily earnings show a gain of five per cent over last year. The road which was originally bonded for $1,650,000 is now bonded for $400,000. Plans are being revived to extend the line to Waterloo, Ind. H.

TELEPHONE AND TELEGRAPH.

(Special Correspondence.)

DAYTON, WASH.—The Mount Vernon Telephone Company has applied for an exclusive franchise in this city. A.

HARRISON, ARK.—B. F. McCoid and others have organized a company to construct a rural telephone system.

MELDER, LA.—The Melder-Forest Hill Telephone Company has been chartered with a capital stock of $10,000.

WILTON, N. D.—The North Dakota Independent Telephone Company will construct two more rural lines this fall. C.

OFFERLE, KAN.—The Peoples Co-operative Telephone Company has been chartered with a capital stock of $10,000.

TAHLEQUAH, OKLA.—The Tahlequah-Beggs Telephone Company has been incorporated with a capital stock of $3,000.

BIGHORN, MONT.—The Bighorn Telephone Company has been organized, with a capital of $20,000, to build line to Custer, Mont.

SALEM, ORE.—The Hermiston Telephone and Electric Company, Hermiston, Ore., has been incorporated with a capital stock of $7,000.

COURTLAND, CAL.—The New Freeport Telephone & Telegraph Company has awarded a contract for the erection of a new building here to Hendren & Guth. A.

WABASHA, MINN.—A franchise has been granted to the Greenfield Farmers' Telephone Company to erect poles and maintain a telephone system in the city. C.

GAGE, OKLA.—The Northwestern Telephone Company was recently incorporated with a capital of $1,500 by J. M. Bateman, R. P. Cannon and Ira Schaffer, all of Gage.

LONG BEACH, CAL.—The Pacific Telephone & Telegraph Company will install a conduit system, in connection with its new exchange plant. The total work is estimated to cost $150,000. A.

CHARLES CITY, IOWA.—The Western Electric Telephone Company is planning the expenditure of $40,000 on extensions and improvements to its plant. F. M. Winn, engineer, Des Moines. C.

NEW WASHINGTON, O.—The Cranberry Home Telephone Company has been incorporated with a capital of $10,000, by W. A. High, J. H. Donaldson, A. G. Lederer, O. L. Green and John H. Sharp.

SPOKANE, WASH.—The Interstate Telephone Company will build a new exchange station on Trent Avenue. Connection will be made with the system of the Home Automatic Telephone Company. A.

FORMAN, N. D.—The Forman, Rutland and Havana Telephone Company has been incorporated with a capital of $10,000 by John Powers of Havana and A. E. Land and H. O. Gardner both of Forman.

LOS ANGELES, CAL.—The Pacific Telephone & Telegraph Company has had plans prepared by its engineering department, San Francisco, for a new exchange to be erected on Vernon Avenue. A.

OKLAHOMA CITY, OKLA.—The Farmer's Mutual Telephone Company, of Grady County, has been incorporated with a capital of $600, by H. A. Bloss, of Cement, and L. Delp and A. H. Nelson, of Chickasha.

SAN FRANCISCO, CAL.—The Pacific States Telephone & Telegraph Company has awarded a contract to Taylor & Goericke for the erection of a three-story exchange building on Nineteenth Avenue. The price is $34,000. A.

HEBER SPRINGS, ARK.—The owners of rural telephone lines over various parts of Cleburne County have organized a company and will put in a system of phone lines throughout the county with a central office at this place.

ST. PAUL, MINN.—A permit has been issued to the Northwestern Telephone Exchange Company for the erection of a brick addition, 32 by 73 feet, to its exchange building at Dale Street and Laurel Avenue. The cost will be $20,000. C.

SAN DIEGO, CAL.—The San Diego Telephone Herald Company has been incorporated to furnish a daily service of current events to subscribers, with a capital stock of $350,000. H. A. and M. N. Schmidt and G. Stephens are the incorporators. A.

SEATTLE, WASH.—The Pacific Telephone & Telegraph Company has opened its new station in the University district, to be known as the "Kenwood Evchange." The company now operates eight stations in this city, and contemplates the erection of others. A.

MEDFORD, ORE.—C. H. Moore of Portland, the district superintendent of the Pacific Telephone and Telegraph Company, has announced that his company will in a short time begin work on an additional line involving an expenditure of between $15,000 and $20,000.

LAUREL, MISS.—The Jones County Rural Telephone Company, capitalized at $10,000, has been granted a franchise to enter the city of Laurel. The company has twenty-eight miles of wire already erected, connecting the homes of more than forty farmers near Laurel. A central exchange will be established in Laurel immediately, and it is probable that exchanges will shortly be put in at Moselle and Myrick.

ELECTRICAL SECURITIES.

Of the issue of $25,000 Hardwick, Vt., four-per-cent twenty-year electric light bonds, $20,000 were awarded to the Proctor Trust Company, of Proctor, Vt., at par and accrued interest. An additional offering of bonds will be made within the next two months.

Spencer, Trask & Company offer for sale five-per-cent first-mortgage bonds of the Rome (Ga.) Railway & Light Company, dated January 1, 1907, due 1937. The issue is subject to redemption in whole or part at 105 and accrue interest at any interest date on six months' notice. The total issue consists of $500,000. It is stated that earning applicable to interest on the first mortgage bonds have averaged more than twice the required amount, and for the current year are expected to amount to more than three times the sum needed for interest.

Directors of the Electric Bond & Share Company recommend an increase of $6,000,000 in stock. There is outstanding $2,000,000 preferred and $2,000,000 common, which it is proposed to increase to $5,000,000 preferred and $5,000,000 common. Increased stock is to be sold from time to time to meet capital requirements, subject to the provisions of charter that preferred outstanding shall not exceed outstanding common stock. It is proposed to issue immediately of the common stock $1,500,000. Common stockholders have agreed to take this block at par, subject to certain conditions, principal of which is that certificate of incorporation and by-laws be amended not only to increase stock, but to change preference dividend from five per cent to six per cent yearly. Stockholders favoring the plan are asked to send consent and assignment, with preferred stock certificate endorsed in blank for transfer to Standard Trust of New York or Old Colony Trust Company of Boston. The trust companies will issue transferrable receipts, and if the plan is carried out stockholders will receive six-per-cent preferred for present five-per-cent stock. Time limit for deposit is January 1, 1912.

DIVIDENDS.

Binghamton Railway Company; annual dividend of three per cent on the capital stock. This is an increase of one-half per cent per annum over the rate paid for the past six years.

Brooklyn Rapid Transit Company; quarterly dividend of one and one-quarter per cent, payable October 1.

Connecticut Railway & Lighting Company; preferred quarterly dividend of one per cent, payable November 15.

Louisville Traction Company; quarterly dividend of one per cent, payable October 1.

Northern Ohio Traction & Light Company; a dividend of three-quarters per cent, payable September 15.

Safety Car Heating & Lighting Company; regular quarterly dividend of two per cent on the capital stock, payable October 2 to stock of record September 13.

CLOSING BID PRICES FOR ELECTRICAL SECURITIES ON THE LEADING EXCHANGES AS COMPARED WITH THE PREVIOUS WEEK.

NEW YORK.

	Sept. 4	Aug. 28
Allis-Chalmers common	6⅜	16½
Allis-Chalmers preferred	17	17
Amalgamated Copper	57¾	57¼
American Tel. & Cable	78⅜	*78⅜
American Tel. & Tel.	134¼	132⅜
Brooklyn Rapid Transit	75⅝	74¾
General Electric	151	151
Interborough-Metropolitan common	14½	14
Interborough-Metropolitan preferred	43½	42⅛
Kings County Electric	129	129
Mackay Companies (Postal Telegraph and Cables) common	82½	83
Mackay Companies (Postal Telegraph and Cables) preferred	72	72
Manhattan Elevated	134	134
Metropolitan Street Railway	*18	*18
New York & New Jersey Telephone	103	103
Pacific Tel. & Tel.	37½	37¾
U. S. Steel common (ex-dividend)	69⅞	69⅞
U. S. Steel preferred	114½	114
Western Union	74	74
Westinghouse common	64	64
Westinghouse preferred	112	112

*Last price quoted.

BOSTON.

	Sept. 4	Aug. 28
American Tel. & Tel.	134¼	132¾
Edison Elec. Illuminating	286	286
General Electric	151	151
Massachusetts Electric common	17½	17¼
Massachusetts Electric preferred	89	88
New England Telephone	146	145
Western Tel. & Tel. common	16½	16½
Western Tel. & Tel. preferred	96½	96½

PHILADELPHIA.

	Sept. 4	Aug. 28
American Railways	45	44¾
Electric Company of America	12	11¾
Electric Storage Battery common	51½	51
Electric Storage Battery preferred	51½	51
Philadelphia Electric	17	16⅞
Philadelphia Rapid Transit	22¼	22¼
Philadelphia Traction	84¾	84¾
Union Traction	50½	50¼

CHICAGO.

	Sept. 4	Aug. 28
Chicago Elevated Railways common	24	24
Chicago Elevated Railways preferred	85	85
Chicago Railways, Series 1	91	90
Chicago Railways, Series 2	28	27
Chicago Subway	2¾	2½
Chicago Telephone	120	120
Commonwealth Edison	132	132
National Carbon common	100	100
National Carbon preferred	115	115

PERSONAL MENTION.

S. Z. DE FERRANTI, president of the Institution of Electrical Engineers of Great Britain, recently arrived in New York and will spend about three weeks in this country.

A. A. MICHELSON, head of the department of physics at the University of Chicago has been the exchange professor at the University of Gottingen during the summer semester of 1911.

GEORGE F. SEVER, until recently professor of electrical engineering in Columbia University, has become consulting electrical engineer for the Department of Water Supply, Gas and Electricity, in the City of New York.

P. J. MORRISEY, formerly connected with the Detroit Edison Company, has succeeded H. H. Weaver as general manager of the Citizens Light, Heat & Power Company, of Johnstown, Pa. Mr. Weaver still retains his office of vice-president of the company.

W. W. REECE, formerly of the Corn Products Refining Company, has recently taken charge of the power plant economy department of the W. H. Zimmerman Company, engineers and constructors, whose offices are in the First National Bank Building, Chicago Ill.

E. SMITH, of Canal Dover, O., has been appointed general manager of the Toledo, Fostoria & Findlay Electric Railway, filling the vacancy caused by the recent resignation of Fred W. Adams. Mr. Adams has been with the company for eight years, and under his direction the line was extended to Pemberville and later to Toledo.

EDGAR F. SMITH, vice-president of the American Electrochemical Society, and provost of the University of Pennsylvania, is in Europe as the representative of his university at the celebration of the five hundredth anniversary of the founding of the University of St. Andrews in Scotland and the one hundredth anniversary of the founding of King Frederick University in Christiana, Norway. He will also visit Gottingen, as this year is the thirty-fifth anniversary of his graduation from that university.

JAMES DANIEL MORTIMER has been elected president of the Union Electric Light & Power Company, of St. Louis, Mo., which office has been vacant since the resignation of Alten S. Miller in June. He is also the successor of John F. Beggs as general manager of the properties controlled by the North American Company. Mr. Mortimer started commercial life selling newspapers, and, before entering college, operated an irrigation pumping plant in Southern California. He graduated from the University of California in 1900, and pursued a post-graduate course in mathematics. From August, 1900, to February, 1902, he was assistant in electrical engineering at the University of California. The next positions which he held were: Superintendent of power for the Tacoma Railway & Power Company and the Puget Sound Electric Railway Company, electrical engineer for the Puget Sound Power Company and Stone & Webster, engineer for the Electric Bond & Share Company, engineer and assistant manager of the corporation department of the Electric Bond & Share Company, manager of the operating department and finally vice-president of the Electric Bond & Share Company. Mr. Mortimer was elected vice-president of the North American Company in October, 1909. He now holds the following offices with the North American Company and its subsidiary corporations: Vice-president, secretary and general manager of the North American, vice-president and secretary of the West Kentucky Coal Company, vice-president and secretary of the Mississippi River Power Distributing Company, vice-president, secretary and general manager of the Milwaukee Electric Railway & Light Company and the Milwaukee Light, Heat & Traction Company; president of the Milwaukee Central Heating Company, president of the Racine Gas Light Company, vice-president of the St. Louis County Gas Company and the Suburban Electric Light & Power Company, and president of the Union Electric Light & Power Company.

OBITUARY.

S. H. BURBURY, known for his work in mathematerial physics, died recently in England at the age of eighty. He was the joint author, with H. W. Watson, of works on "Electrostatics" and "Electrodynamics."

JAMES CHRISTIE, president of the Engineers Club, and vice-president of the Franklin Institute, of Philadelphia, recently died of apoplexy at Atlantic City. He was seventy-one years old. Mr. Christie had a long career as a mechanical engineer. He resigned his position as chief engineer of the American Bridge Company in 1905, to devote his time to private business.

NEW INCORPORATIONS.

CHICAGO, ILL.—The Service Electric Company was recently incorporated with a capital of $5,000 by Gerald G. Barry, Andrew W. Little and Lee Cohn. The purpose is the manufacture of electrical machinery.

CHICAGO, ILL.—The Midland Electrical & Manufacturing company has incorporated with a capital of $50,000 for the purpose of manufacturing mechanical devices. Andrew Engstrom, Arthur O. Carlson, Frederick Deiser are the incorporators.

NEW YORK, N. Y.—The Ideal Electric Inspection & Maintenance Company has been incorporated with a capital of $25,000 by William E. McKeen, S. L. Moxham and F. Lask. The company will deal in electrical apparatus, etc.

NEW YORK, N. Y.—The McDonald, Gibson Company, has been incorporated by Mayer & Gilbert, John C. McDonald, William Gibson and Daniel McDonald. The company has a capital of $25,000 and will deal in electrical devices.

SAN FRANCISCO, CAL.—The West Sacramento Electric Company has been incorporated by Benjamin P. Lillienthal, Herbert W. Furlong, William Herlitz, Thomas Gregory and C. J. Goodell with a capital stock of $100,000.

WARREN, IND.—The Granger Electric Manufacturing Company has incorporated with a capital of $50,000. The company proposes to establish and equip a factory to manufacture electric devices of all kinds. The directors are: Francis Granger, R. L. Tobin, Frank Canady, George G. Kreigbaum and Ralph Meyers. S.

SALT LAKE CITY, UTAH.—The Electrical Show Association of Utah has been incorporated to engage in electrical shows, general entertainment business, general electrical business, to deal in electrical supplies and to engage in the handling of electrical signs and so on. The capital stock is $5,000. The officers are: B. W. Mendenhall, president; C. B. Hawley, vice-president; R. J. Dinwoodey, secretary; William Kennedy, treasurer.

PROPOSALS.

HOIST EQUIPMENT.—The following calls for electrical supplies have been issued by the Bureau of Supplies and Accounts, Navy Department proposals for which will be opened September 12, 1911:

For the Brooklyn Navy Yard: Ten Upper-hoist equipments; eleven lower-hoist motors and brakes; ten elevator equipments; ten rammer equipments; one electrically driven reversible two-speed deck winch, complete.

To be delivered at Newport News: Ten upper-hoist equipments; ten lower hoist motors and brakes; ten elevator equipments; ten rammer equipments.

MOTORS—The purchasing agent, Bureau of Supplies and Accounts, Navy Department, Washington, D. C., is calling for bids on electrical supplies. On September 12, bids will be received for the following material to be delivered at the Eastern Yards:

Four thirty horsepower, 220-volt, three-phase, sixty-cycle, 400-revolutions per minute synchronous-speed, eighteen-pole induction motors, complete, with oil-immersed auto-starters. The Bureau of Steam Engineering is calling for bids on insulating tape, rubber and cotton; orders to be for not less than $5,000 or more than $9,000 in value for both classes of tape. On September 19 proposals will be opened for material for the Brooklyn Yards as follows:

One 3½-horsepower, 220-volt, semi-inclosed, adjustable-speed motor, for 22-inch Dodge & Shipley engine lathe, No. 173.
One 2-horsepower, 220-volt, semi-inclosed, adjustable-speed motor, for 20-inch Hendey engine lathe, No. 143.
One ¾-horsepower, 220-volt, semi-inclosed, adjustable-speed motor, for 10-inch Pratt & Whitney toolmakers' lathe, No. 137.
One 3-horsepower, 220-volt, semi-inclosed, adjustable-speed motor, for Pratt & Whitney 26-inch upright drill, No. 132.
One ¾-horsepower, 220-volt, semi-inclosed, adjustable-speed motor, for Prentice 19-inch upright drill, No. 80.
One ¾-horsepower, 220-volt, semi-inclosed, adjustable-speed motor, for Prentice 19-inch upright drill, No. 121.
One ¾-horsepower, 220-volt, semi-inclosed, adjustable-speed motor, for Foote-Burt three-spindle upright drill, No. 131.
One ½-horsepower, 220-volt, semi-inclosed, adjustable-speed motor, for Sigourney small sensitive drill, No. 64.
Two 2-horsepower, 220-volt, semi-inclosed, adjustable-speed motors, for double head turret drill, No. 109.
One 2-horsepower, 220-volt, semi-inclosed, adjustable-speed motor, No. 3 Brown & Sharpe milling machine, No. 134.
One 2-horsepower, 220-volt, semi-inclosed, adjustable-speed motor, for No. 3 Becker vertical milling machine, No. 102.
One 3½-horsepower, 220-volt, semi-inclosed, adjustable-speed motor, for No. 5 Becker vertical milling machine, No. 21.
One 2-horsepower, 220-volt, 1, 150-revolution-per-minute, compound-wound, semi-inclosed, constant-speed motor, for Besley No. 2 lapping wheel, machine No. 88, and Wells universal grinder, No. 141.
One 3½-horsepower, 220-volt, 600-revolution-per-minute, compound-wound, semi-inclosed, constant-speed motor, for Diamond No. 5 water grinder, No. 150.
One 3-horsepower, 220-volt, 1, 150-revolution-per-minute, compound-wound, semi-inclosed, constant-speed motor, for Diamond No. 6 double-wheel grinder, No. 155.
One 3½-horsepower, 220-volt, semi-inclosed, adjustable-speed motor, for 16-inch Pond planer, No. 17.
One 2½-horsepower, 220-volt, semi-inclosed, adjustable-speed motor, for Fay & Company 36-inch band saw, No. 14.
One 2-horsepower, 220-volt, 1, 150-revolution-per-minute, compound-wound, semi-inclosed, constant-speed motor, complete, with plain automatic starter, for No. 21 Bliss power press, No. 139.

MECHANICAL EQUIPMENT.—The Supervising Architect, Washington, D. C., announces that the time for opening bids for the mechanical mail-handling system of the United States Postoffice Building, Washington, D. C., has been extended from September 15 to October 10. The time for opening bids on the electric elevator plant of the building has also been extended from September 15 to October 10.

WIRING.—Sealed proposals will be received at the office of the Supervising Architect until September 15 for the construction, complete (including plumbing, gas piping, heating apparatus, electric conduits and wiring, and lighting fixtures) of the United States postoffice at Pendleton, Ore., in accordance with drawings and specifications, copies of which may be obtained from the custodian of site at Pendleton, or at the Supervising Architect's office.

LEGAL NOTES.

CONFISCATORY RATES.—The Southern California Edison Company has brought suit in the United States Circuit Court, Los Angeles, to restrain the city of Santa Ana from enforcing an electric light ordinance, establishing a minimum of fifty cents a month with rate of seven cents per kilowatt hour, for a demand of 250 to 8,000 kilowatts, and one and one-half cents above 8,000 kilowatts. The company claims that physical valuation will prove that rates are confiscatory. A.

NOTICE REQUIRED FOR REMOVAL OF POLES.—In order to entitle a municipality to proceed by mandamus to compel a telephone company to remove one of its poles, lawfully erected on one of its streets, it must first notify such company particularly and definitely of what it desires it to do. If the municipality has reserved the right to select the location for such poles, the notice to remove is incomplete and insufficient in law, if it fails to designate particularly the place to which, as well as the place from which, it desires the pole to be removed.—Supreme Court of Appeals of West Virginia in Town of New Martinsville vs. Enterprise Telephone Company, 70 S. E. 700.

CANNOT COMPEL FREE LAMPS.—The ordinance adopted by the City Council, Los Angeles, Cal., shortly after reducing the lighting rates from nine to seven cents in July, 1910, providing for the lighting companies to supply incandescent lamps to consumers without charge has been declared unconstitutional by the Supreme Court. The decision declares that the Council has not the power to regulate the charge to be made for lamps or to order same supplied free, any more than it is permitted to determine the cost of wiring a house for current. The charge for lamps is the private business of the companies. The city, in its case, held that the cost of furnishing lamps had been considered in fixing the rate. A.

COMPANY NOT LIABLE FOR INQUIRY DURING ELECTRICAL STORM.—The Supreme Court of Pennsylvania holds that the mere fact that a person going to a telephone during a severe electrical storm is injured by a shock on taking the receiver off the hook does not show actionable negligence on the part of the company, or shift the burden of proof to it. What is termed the maxim of *res ipsa loquitur*, or the matter speaks for itself, does not apply. Nor is negligence shown by evidence that the company did not place a warning on the telephone against its use during electrical storms. The contention to the contrary overlooks the well-settled rule that the test of negligence in methods, machinery and appliances is the ordinary usage of the business. One cannot be convicted of negligence if he employs in his business the methods and appliances in general use by those engaged in a like business; on the other hand, if he fails to use such methods and appliances and an injury results therefrom, he may be required to convince a jury that his methods and appliances were of equal or superior merit to those in general use. The doctrine of the electric light and power cases cited by the plaintiff was not applicable to the facts of the present case, for in those cases it appeared that the injury was caused by an electric current which was, or should have been, under the control of the defendant, and the exercise of proper care by it would have prevented the accident, while here the undisputed testimony showed that the plaintiff was injured by a current of atmospheric electricity or lightning against which there was no absolute protection, but against which the defendant company tried to protect the plaintiff and others using the telephone by placing on it the best and most efficient protective device then known.—Rocap vs. Bell Telephone Company of Philadelphia, 79 Atl. 769.

RATES IN TOLEDO, O.—Judge Manton, of the Toledo Common Pleas Court, has granted an injunction asked by the City restraining the Toledo Railways & Light Company from demanding or receiving a higher rate for electric lighting than that prescribed by the City Council in an ordinance recently passed, fixing the charges at eight cents per kilowatt-hour, with a one cent discount on all bills paid before the tenth of the month, and a minimum charge of fifty cents. The old rate was ten cents per kilowatt-hour, with a ten-per cent discount if paid before the tenth of the month, and a minimum charge of one dollar. The company refused to conform to the requirements of the new ordinance, and sent out its statements to customers at the old rate, but announced that it was willing to accept the new rate as a payment on bills, but would not receipt in full. Of the 6,400 patrons many paid their bills in full. Under the order of the court the company is compelled to abide by the new ordinance pending litigation, and will not be permitted to charge in excess of the rates provided, or to receive the same if tendered. The court orders that a bond of $5,000 must be filed by the city to indemnify the company against any loss which may result by reason of the difference in rates during litigation. The company contends that the ordinance is unreasonable and confiscatory, and the matter will be decided in the higher courts. In the meantime patrons of the company will pay the lower rate and if the City is unsuccessful in its suit the bond will be held for the difference. Prominent attorneys hold that there is a grave question whether municipalities are authorized by law to file such a bond, in which case the company would be compelled to recoup its losses from patrons or stand it itself. At any rate the seven-cent electric lighting rate will be in force in Toledo as soon as the City files the bond required by the court. H.

INDUSTRIAL ITEMS.

THE ROME WIRE COMPANY, Rome, N. Y., has mailed post cards advertising bare and tinned copper wire, magnet and annunciator wire and rubber-covered code and telephone wires.

THE BEARDSLEE CHANDELIER MANUFACTURING COMPANY, Chicago, Ill., shows illustrations of the most complete and up-to-date designs of electric lighting fixtures in catalog No. 17, which was recently sent out. The fixtures are especially designed for Mazda or tungsten lamps.

THE AUTOMATIC WASHER COMPANY, Newton, Iowa, has issued a small booklet, entitled "How To Wash," which contains much information of value to every housewife and user of electric washing machines. The company, of which Harry L. Ogg is president, will take pleasure in mailing this booklet to anyone interested.

THE FRANK ADAM ELECTRIC COMPANY, St. Louis, Mo., has prepared a catalog of its latest designs of popular and medium grades of ceiling lights, shower fixtures and brackets. The company announces that it is ready to furnish, on request photographs or special designs of more elaborate styles suitable for fine residences, public buildings, court houses, churches and office buildings.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., announces the opening on September 1 of offices in San Francisco, Cal., in Room 400, First National Bank Building. Motors, generators and transformers of various sizes will be carried in stock for immediate coast shipments. John S. Baker, well known among the electrical trade on the Pacific Coast, has been placed in charge.

THE GARVIN MACHINE COMPANY, New York, N. Y., announces in a recent catalog that owing to the diversity of its line of manufacture, all exclusive selling arrangements (Great Britain excepted) have been discontinued. Orders may now be placed through any reputable machinery dealer. The catalog lists profiling machines, milling machines, slotting machines, etc., showing each type by illustration.

THE MILLAR ELECTRIC COMPANY, Chicago, Ill., announces that on and after September 1, its entire business will be transferred to and conducted by the Granger Electric & Manufacturing Company, of Warren, Ind., where it has arranged for a factory to take care of the rapidly increasing business. The company's present line of heating appliances will be added to as soon as the new devices can be placed on the market.

THE WIRT ELECTRIC SPECIALTY COMPANY, Philadelphia, Pa., describes the "Dim-a-Lite" in a recently distributed booklet. The attachment by the aid of which five intensities of light may be obtained is characterized in the publication as a "vest pocket rheostat." Four illustrations show an incandescent light with full candle power, two candle-power, one-quarter candle-power, and turned down for use as a night light.

THE MALONEY ELECTRIC COMPANY, St. Louis, Mo., describes the Maloney high-efficiency transformers in a recent bulletin. Questions such as core-loss, copper-loss, regulation, etc., are each discussed separately, nearly every other page throughout the publication being given over to illustrations making clear the various features of construction. A number of tests are described in detail in connection with diagrams of connections.

THE ADVANCE ELECTRIC COMPANY, St. Louis, Mo., briefly tells the story of the development of Advance repulsion motors in a recent folder. The statement is made therein that the Advance was among the first commercially successful full-load-starting, constant-speed, single-phase motor that did not require automatic devices of some kind. The first of these motors, put out some five years ago, are said to be giving satisfactory service at present.

W. F. SLOAN and W. J. HUDDLE have organized to carry on their advisory and consulting practice under the firm name Sloan, Huddle & Company, with offices in the Carroll Block, Madison, Wis. The firm, through its members and associated experts, is equipped for general engineering work and gives especial attention to appraisals, statistical investigations, engineering examinations and reports for rate making, bond issues, reorganizations, insurance and industrial purposes.

THE MESTA MACHINE COMPANY, Pittsburgh, Pa., has issued a reprint of a booklet describing its plant and giving a program of the recent inspection trip and visit to the company's plant made by the American Society of Mechanical Engineers and the Engineer's Society of Pennsylvania. The booklet is prepared in an attractive manner, shows many views of various parts of the plant, and contains a special feature that was not a part of the original publication; this being a double page illsutration of the members who made the inspection trip.

THE ATLAS ENGINE WORKS, Indianapolis, Ind., dedicates its recent bulletin on Atlas crude-oil engines (Diesel type), to the "consulting engineer, the operating engineer, the plant owner, the manufacturer, the general manager, the superintendent, and especially to the man who pays the bills." The publication deals with the economy and the advantage of the Atlas engine and compares costs of operation with that of steam engines, and producer-gas engines. A number of the characteristics of the engine, its design and construction, etc., are given; numerous half-tone engravings and drawings showing the details in a convenient manner.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, Pittsburgh, Pa., has recently received a large number of important orders among which is one from the Minneapolis General Electric Company, of Minneapolis, Minn., for three 1,000-kilowatt, oil-insulated, water-cooled, 13,200-volt transformers. Another order from the Great Shoshone & Twin Falls Water Power Company, of Twin Falls, Idaho, calls for five seventy-five-kilowatt, 24,000-volt, oil-insulated, self-cooled transformers. The Pacific Gas & Electric Company, of San Francisco, Cal., has ordered from the same company ten 1,000-kilowatt, oil-insulated, self-cooled, tubular-type, 11,000-volt transformers.

H. M. HIRSCHBERG, New York, N. Y., has concluded arrangements for the exclusive importation of Plania carbons. The Plania works at Ratibor, Silesia, employing over 1,800 hands, is one of the largest, if not the largest, carbon factories in Europe, which virtually means the world. Besides arc-lamp carbons for all types of flaming enclosed, open and miniature lamps, the company owning the Plania works is the only manufacturer of large carbon electrodes for electric smelting and refining purposes. Large quantities of this material are at present used in this country and Canada by the most important smelting and refining works. A full stock of all sizes and types of arc-lamp carbons will be constantly carried, in order that the requirements of both domestic and export trade can be properly cared for.

THE DETROIT FUSE & MANUFACTURING COMPANY, Detroit, Mich., is distributing profusely illustrated folders on "Detroit" three-phase motor starter and "Arkless" mechanical indicating fuses. These folders show six views each of the Detroit motor starter in operation and an Arkless fuse installation in addition to descriptive matter relative to the merits of these lines, and are part of a series of folders covering the practical applications of Detroit iron-clad fuses and switches and Arkless mechanical indicating fuses. This advertisement is being sent to the electrical trade and also forwarded to large plants throughout the country in cooperation with the various jobbers and dealers who are handling Detroit products. These folders and complete information will be forwarded to anyone taking the matter up with the manufacturers.

ALFRED F. MOORE has recently notified the trade that he is prepared to furnish enameled wire, either plain or insulated with silk or cotton as desired for certain purposes. The demand for enameled wire is steadily increasing and it will no doubt be a source of satisfaction to the users of this product to know that they can deal with such a responsible firm. All of the bare wire used for enamelling is specially drawn and has to pass a rigid examination before it is available for use. The process of enamelling is done under the direct supervision of skilled and experienced employees and the finished product is subjected to physical and electrical tests that insure a uniformly high standard of quality throughout. A complete stock of enameled wire is carried at the factory and a supplementary stock in Cleveland and Chicago for the convenience of their trade in the Central West.

THE GENERAL ELECTRIC COMPANY has just issued Bulletins No. 4837 to 4843 inclusive, which form a series illustrating and describing in detail all of the circuit breakers manufactured by that company. Bulletin No. 4837 contains a general description of the applications of circuit-breakers and contains also notes and diagrams descriptive of standard practice in the use of carbon-break circuit-breakers for various requirements. Specifications suggested for the use of engineers, architects, and others wishing to secure uniformity in quality of apparatus and illustrations of typical installations of circuit breakers on modern switchboards, are given. Bulletin No. 4838 is devoted to circuit-breakers of large capacity for severe service, used in railway, power and lighting installations. Bulletin No. 4839 describes circuit-breakers of intermediate capacities for any service, used in lighting, power and railway installations. Bulletin No. 4840 is devoted to circuit-breakers that are specially adapted to motor-driven tool applications, for use in mills, machine shops, factories, foundries and office buildings, and for general motor work, automobile charging outfits, storage batteries, rectifier sets, etc. Bulletin No. 4841 describes circuit-breakers for small capacity motor, lighting and heating circuits. Bulletin No. 4842 refers to remote-control circuit-breaker for use in railway, lighting and power installations, especially in those cases where economy of space, ease of operation and distant control are deciding factors.

DATES AHEAD.

International Association of Municipal Electricians. Annual convention, Atlantic City, N. J., September 12-15.

Vermont Electrical Association. Annual meeting, Lake Dunmore, Vt., September 13-14.

Colorado Electric Light, Power and Railway Association, Glenwood Springs, Colo., September 13-15.

International Municipal Congress and Exposition. Chicago, Ill., September 18-30.

Association of Edison Illuminating Companies. Annual convention, Spring Lake, N. J., September 19, 20 and 21.

Northwest Electric Light and Power Association. Annual convention, Spokane, Wash., September 21-22.

American Electrochemical Society. Twentieth general meeting, Toronto, Canada, September 21-23.

Illuminating Engineering Society. Annual convention, Chicago, Ill., September 25-27.

National Conservation Congress, Kansas City, Mo., September 25, 26 and 27.

American Mining Congress. Thirteenth annual meeting, Chicago, Ill., September 26-29.

Georgia Section of the National Electric Light Association. Annual convention, Columbus, Ga., September 26 and 27.

National Association of Cotton Manufacturers. Semi-annual meeting, Equinox House, Manchester, Vt., September 27-30.

American Electric Railway Association and affiliated associations. Annual convention, Atlantic City, N. J., October 9-13.

Association of Railway Electrical Engineers. Annual convention, La Salle Hotel, Chicago, November 6-10.

National Electric Light Association. Next annual convention, Seattle, Wash., June 10-14, 1912.

Directory of Electrical and Allied Engineering and Scientific Societies

(Published in the second issue of each month.)

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RECORD OF ELECTRICAL PATENTS.

Issued (United States Patent Office) August 29, 1911.

1,001,627. ART OF COOKING. Austin C. Dunham, Hartford, Conn. Filed April 14, 1911. A heating element in a fireless cooker is supplied with only enough current to keep the cooker at a constant temperature.

1,001,630. FILAMENT MOUNTING. Edgar S. Gardner, Acquackanonck, N. J., assignor to General Electric Co. Filed Nov. 17, 1910. The filament is looped back over supplemental carriers which are arranged midway between the main filament carriers.

1,001,636. TROLLEY. Clarence A. Gouty, Springfield, Ill., assignor of one-half to Henry F. Long, Springfield, Ill. Filed June 23, 1910. The shaft of the trolley wheel is free to oscillate upward and downward in grooves in the trolley harp. The blocks in which the axle is held are pushed upward toward the trolley by coiled springs.

1,001,637. ELECTRICAL OVEN. Harold Gray, Accrington, England. Filed April 20, 1911. Partitions are arranged inside the oven in such a manner as to form flues. The air in contact with the heating elements rises in the flue, keeping a current of air continually flowing past the heating elements, and through the middle of the oven.

1,001,643. DYNAMO-ELECTRIC MACHINE. Fred B. Howell, Schenectady, N. Y., assignor to General Electric Co. Filed Dec. 30, 1909. The field coils are ventilated by tubes which are embedded in the windings. The cooling fluid is directed against the armature after leaving the cooling tubes.

1,001,647. SPEED REGULATOR FOR ELECTRIC MOTORS. Julius T. Kalweit and William H. Gaulke, Milwaukee, Wis., assignors to Independent Electric Manufacturing Co. Filed Oct. 20, 1910. Combines a contact-arm, means for resiliently moving it into the starting position, an electromagnet, a sliding-bar guided to reciprocate in an endwise direction and having a plurality of notches on its upper side, an intermediate member connecting the bar with the arm, and a toothed member with which the notches are adapted to engage in the respective positions of the arm; the electromagnet being operatively connected with the arm and adapted when energized to hold the member in engagement with the notches.

1,001,649. ELECTRIC LAMP FIXTURE. John H. Kingsley, Manchester, Mich., assignor to Detroit Auto Specialty Co., Detroit, Mich. Filed Nov. 19, 1910. A pair of plates is arranged in a vertical position beneath the reflector, one lamp being in each angle formed by adjacent sides of the plate.

1,001,650. SWITCHING MECHANISM. Kenneth Francis Kingwell, Rugby, England, assignor to General Electric Co. Filed Dec. 14, 1905. Has an operating lever, a handle, differential gearing between lever and handle, means for locking the gearing to the handle through a portion of its range of movement, also a spring, and means controlled by the spring operative upon the release of the gearing from the handle for completing the movement of the lever.

1,001,656. HEATING FURNACE. Wesley W. Lininger and James G. Pitton, Denver, Colo. Filed March 23, 1910. An electric motor forces air into a gas burner which is arranged to heat a conduit. A valve controls the supply of fuel to the burner, this valve being operated by an electrical device.

1,001,664. REFRIGERATING SYSTEM. Albert T. Marshall, Hartford, Conn., assignor to the Automatic Refrigerating Co., Hartford, Conn. Filed June 18, 1908. Thermostats regulate the refrigerant supply to each chamber to maintain the predetermined temperature of each chamber. The operation of the compressor automatically stops when all of the chambers have assumed their desired temperature.

1,001,671. CIRCUIT-BREAKER FOR ELECTRIC IGNITION DEVICES. Arthur R. Mosler, New York, N. Y., assignor to A. R. Mosler & Co., New York, N. Y. Filed March 28, 1905. Has a rotary shaft carrying a movable primary contact and a movable secondary distributer, and a casing made in two separable parts,

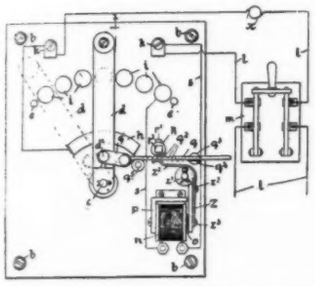
each of the parts comprising a ring and a plate, the casing carrying a stationary primary contact and a secondary terminal.

1,001,685. TELEPHONE. Arthur G. Remhilt, Philadelphia, Pa. Filed Sept. 7, 1910. Comprises a mouthpiece, an arm movable on the mouthpiece, a receiver connected to the arm and movable with respect thereto, means for locking the receiver and arm together, and means for locking the movable arm on the transmitter mouthpiece and simultaneously unlocking the receiver to permit of its movement to operative position.

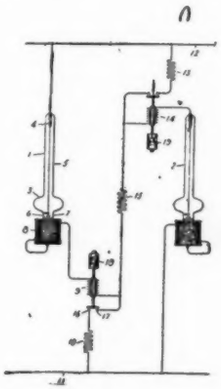
1,001,694. FUSE PLUG. Howard R. Sargent, Schenectady, N. Y., assignor to General Electric Co. Filed Jan. 8, 1910. Has a cup-shaped base, with a notch connecting the interior of the base with an external peripheral groove. A cover is provided for the open end of the base and for the groove.

1,001,709. VAPOR ELECTRIC APPARATUS. Elihu Thomson, Swampscott, Mass., assignor to General Electric Co. Filed March 14, 1904. Comprises a container, electrodes therefor, one at least of which is mercury, an insulating tube open at each end for confining a small thread of mercury, and means for vaporizing the mercury thread by the passage of current.

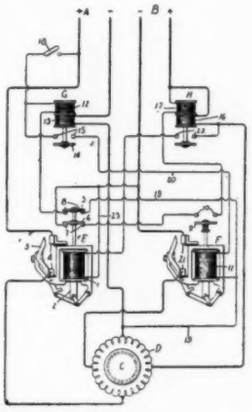
1,001,710. SYSTEM OF ELECTRICAL DISTRIBUTION. Elihu Thomson, Swampscott, Mass., assignor to General Electric Co. Filed March 11, 1905. The combination of a source of current, a plurality of mercury-vapor devices, means for starting the lamps in parallel, and automatic means for subsequently disposing the devices in series with respect to the source of current.



1,001,647.—MOTOR SPEED REGULATOR.



1,001,710.—SYSTEM OF DISTRIBUTION.



1,001,760.—MOTOR-STARTING DEVICE.

1,001,711. SYSTEM OF VOLTAGE REGULATION. Allen A. Tirrill, Schenectady, N. Y., assignor to General Electric Co. Filed Jan. 4, 1909. The field excitation of the exciter and its booster, in series, are simultaneously varied. A regulator shunts the resistances in the fields to cause the variation.

1,001,716. OIL-SWITCH. John M. Wallace, Newbold-upon-Avon, England, assignor to General Electric Co. Filed Nov. 2, 1906. Covers the mechanism which allows the movable and fixed contacts to be simultaneously adjusted in a horizontal plane.

1,001,719. INCUBATOR ALARM. Lee J. Westfall, Omaha, Neb. Filed May 8, 1911. Too great temperature changes in the incubator ring on electric bell.

1,001,723. TELEPHONE SYSTEM. Charles S. Winston, Chicago, Ill., assignor to Kellogg Switchboard and Supply Co., Chicago, Ill. Filed Nov. 22, 1907. Comprises a pair of telephone lines, a cord circuit to connect therewith, cut-off relays for the lines, a pair of supervisory relays for the cord circuit actuated through the coils of the cut-off relays and independent of the talking circuit when the cord is connected with the lines, a pair of supervisory relays for the cord circuit in one of the talking strands and under the control of the subscribers, and a pair of supervisory signals, each having its circuit controlled solely by the conjoint action of two of the relays, each signal circuit including contacts of its control relays.

1,001,733. MEANS FOR ELIMINATING THE GLARE OF LAMPS. John W. Dalman, Chicago, Ill. Filed Aug. 22, 1910. A double reflector in connection with a shade over the upper half of the lamp directs the light downward.

1,001,737. CURRENT-LIMITING DEVICE. Manuel Garcia Diaz, Carthagena, and Antonio Azarola y Gresillon, Madrid, Spain. Filed Aug. 22, 1908. An expansible vessel in circuit is provided with heating coils. An adjustable contact controlled by the expansion of the vessel controls the circuit, a shunt circuit containing an auxiliary resistance being adapted to convey current when the contact is broken, and a vessel in close proximity to the expansible vessel containing the auxiliary resistance adapted to be heated by the current.

1,001,742. ELECTRIC TRAIN-SIGNAL. Ernst F. von Dreden, New York, N. Y. Has a plurality of electro-magnets, armatures, controlled thereby, a circuit adapted to be closed by the armatures, means provided in each car for closing one of the electro-magnet circuits and means for indicating which circuits have been closed.

1,001,758. INCUBATOR TEMPERATURE REGULATOR. Irvin B. Havourd, Elkhart, Ind. Filed Sept. 16, 1909. A motor moves the lamp wick upward and regulates the damper as required to keep a constant temperature in the incubator.

1,001,765. MOTOR STARTING DEVICE FOR POLYPHASE CIRCUITS. Walter O. Lum, Schenectady, N. Y., assignor to General Electric Co. Filed July 24, 1908. Has a plurality of electric-magnetic switches for separately closing the circuits of the different phases, and a relay having an actuating circuit and a holding circuit in one phase arranged to control the switch in another phase.

1,001,796. SELF ADJUSTABLE CONTACT MAKER FOR ELECTRIC SWITCHES. Frank W. Young, Everett, Mass., assignor to Sears B. Condit, Jr., Boston, Mass. Filed Dec. 26, 1905. Comprises separated contact blocks, a movable contact element for spanning them, a movable carrier for operating the movable contact element, and a backing support pivoted to the movable carrier affording a seat for the movable contact element, the backing support having provision to permit yielding of the movable contact element in all directions.

1,001,828. ELECTRIC SIGNAL FOR RAILWAYS. Thomas J. Empfield, Des Moines, Iowa. Filed Oct. 8, 1910. Two signaling circuits each contains a signal at each end of the block, the circuits being normally broken. A single circuit controller is provided for each signaling circuit, each controller operated by an electromagnet setting all of the signals in the circuit. Each electromagnet may be momentarily magnetized, locking devices for the controllers maintaining the circuits closed after the magnets are deënergized. Electrically operated devices are controlled by the cars in passing out of the block to unlock the locking devices and thereby open the closed circuit. A hand operated switch is put in circuit with each unlocking device.

1,001,843. LAMP SOCKET. Leo Güdeman, New York, N. Y. Filed Feb. 4, 1911. A cylindrical sleeve on the lamp socket permits ornamental devices to be fastened to the lamp.

1,001,864. FASTENING FOR ELECTRICAL CONDUCTORS. Rudolph H. Klauder, Philadelphia, Pa. Filed Dec. 15, 1910. Two metal strips are bent in such a way as to hold a conductor tightly between them, yet allowing the conductor to be easily released.

1,001,876. ELECTROLYTIC CELL. Paul McDorman, Dayton, O., assignor to National Laundry Machinery Company, Dayton, O. Filed Dec. 29, 1910. Has an inner vessel provided with a number of openings, a bottom plate with openings, a series of tubes secured within the openings in said plate and extending in proximity to the bottom of the outer vessel, and electrodes mounted in the inner vessel and forming compartments with which the openings in the inner vessel communicate.

1,001,888. ELECTRIC WELDING MACHINE. Adolph F. Rietzel, Charlestown, R. I., assignor to Universal Electric Welding Co., New York, N. Y. Filed Dec. 24, 1908. Comprises a current bearing pressure block having a yielding contact, adapted to abut against the piece of metal to be welded and a mass of heat-conducting material engaging the sides of the work and formed as described to act as a templet.

1,001,915. ELECTRIC FURNACE. Lars Yngström, Falu Grufva, Falun, Sweden, assignor to Stora Kopparbergs Bergslags Aktiebolag, Falun, Sweden. Filed March 15, 1910. The electrodes are held in place in a crucible-like working chamber, by the material coming from the charging chamber. The new material forms the cover for the furnace.

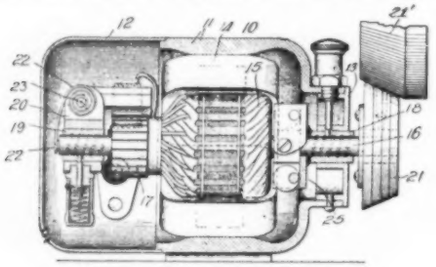
1,001,932. TIME-LIMIT CIRCUIT CLOSER. Fred B. Corey, Schenec-

tady, N. Y., assignor to General Electric Co. Filed March 5, 1909. Comprises a pivotally mounted receptacle, a conducting fluid, a partition dividing the receptacle into two chambers and provided with a restricted opening through which the fluid flows when the receptacle is moved from one position to another, one of said chambers having two branches so arranged with respect to the opening that the fluid can enter one branch only after filling the other, (the amount of fluid being insufficient to fill both branches) and a set of contact terminals in each branch adapted to be connected by the fluid.

1,001,948. COMBINED COVER AND SOCKET PIECE. John Hamilton, Jamaica Plain, Mass. Filed Dec. 16, 1907. A one-piece combination cover and socket piece of insulation material.

1,001,959. TELEPHONE SELECTIVE SIGNALING RINGER. Harry L. Johnson, Topeka, Kans., assignor of six-tenths to Clay Hamilton, Topeka, Kans. Filed Mar. 3, 1908. Renewed Sept. 19, 1910. Comprises a permanent magnet having one end at the opposite side of the vibratory armature from the electro-magnet, and its opposite end secured to the base at the opposite end of such electromagnet, and a second electromagnet adjacent to the permanent magnet and provided with a core-extension at one end contiguous to the armature at the opposite side of the same from the first-named electromagnet and having its opposite end secured to the base.

1,001,975. APPARATUS FOR PRODUCING ELECTRIC OSCILLATIONS. Joseph Murgas, Wilkes-Barre, Pa. Filed April 12, 1910. The combination with an electrode, of a rotary member coöperating with the electrode to form a spark gap, the electrode being provided with transverse perforations adjacent the spark gap,



1,002,191.—DRIVING MECHANISM.

and means associated with the rotary member to direct an air current on the electrode and rotary member.

1,002,036. ELECTRICAL SOUND-PRODUCING DEVICE. Edward E. Clement, Washington, D. C. Filed Aug. 11, 1905. An electromagnet is positioned with relation to a sound-producing body so as to vibrate the same and establish a predetermined nodal point, another magnet or magnets being positioned with relation to the body so as to induce vibrations having other nodal points, electrical circuit connections for the magnets, a source of current supply connected thereto, and controlling means for the circuits.

1,002,049. SIGNALING BY ELECTROMAGNETIC WAVES. Reginald A. Fessenden, Fortress Monroe, Va., assignor to National Electric Signaling Co., Pittsburg, Pa. Filed Aug. 8, 1903. Comprises a conductor for leading the received impulses into the receiving station, two circuit elements operatively connected to the conductor, and a circuit containing a receiver, operatively connected to the circuit elements in such a manner that the circuit elements produce voltages approximately equal but opposite in sign in the circuit containing the receiver, on the receipt of disturbing impulses, and voltages differing in magnitude on the receipt of the desired impulses.

1,002,050. RECEIVER FOR SIGNALING. Reginald A. Fessenden, Washington, D. C., assignor to National Electric Signaling Co., Pittsburg, Pa. Filed Apr. 11, 1904. Has in combination two parts or members, one of the members being of a yielding nature, means for continuously changing the point of contacts of the members, and means for selecting signals of a definite group frequency.

1,002,051. SIGNALING BY ELECTROMAGNETIC WAVES. Reginald A. Fessenden, Washington, D. C., assignor to National Electric Signaling Co., Pittsburg, Pa. Filed Feb. 8, 1907. Has a partly metallic insulated antenna support, and an antenna arranged so that parts of it shield the support from the electromagnetic waves received.

1,002,052. ELECTRIC SIGNALING. Reginald A. Fessenden, Brant Rock, Mass., assignor to National Electric Signaling Co., Pittsburg, Pa. Filed Dec. 23, 1907. A transmitter has a self-responsive good contact of different materials, means being furnished for varying the pressure of the contact by means of the impulses to be transmitted. A local circuit contains the contact and an indicating mechanism.

1,002,061. DROP-CORD CAP FOR ELECTRIC-CONDUIT OUTLET BOXES. Carl S. Homsher, Denver, Colo. Filed Sept. 8, 1910. Comprises a hollow body portion with an aperture therein, an insulating block having a reduced neck inserted through the aperture and projecting above the same so as to form a bushing, the block having on its inner side a rectangular recess and a passage, and metallic plates secured to the opposite short end walls of the recess.

1,002,069. PROTECTIVE DEVICE. Arba B. Marvin, Jr., Schenectady, N. Y., assignor to General Electric Co. Filed Feb. 15, 1907. Includes an electrolyte of high resistance when solid and of low resistance when fused, and electrodes spaced apart in the electrolyte to permit it to remain solid when the protective device is subjected to normal potential and to allow sufficient current to flow between the electrodes to fuse it subjected to a predetermined abnormal potential.

1,002,087. RAILWAY SIGNAL. Richard Skalicky and Franz Mikulka, Vienna, Austro-Hungary. Filed May 31, 1911. The signal is operated by either of two circuits, one being operative when the switch is closed, the other acting when the switch is open.

1,002,090. SHADE HOLDER. James Stoddart, Newark, N. J., assignor to Enos Co., New York, N. Y. Filed May 31, 1911. Relates to details of construction of shade for incandescent lamp.

1,002,113. STRAIN CLAMP. Arthur O. Austin, Barberton, Ohio, assignor, by mesne assignments, to Ohio Insulator Co., Mansfield. Filed Dec. 15, 1909. One of two diverging members at each end clamp the line. The other member holds the conductor in slack condition around the supporting insulator.

1,002,128. TROLLEY WHEEL. Charles M. Brennan, Naugatuck, Conn. Filed Aug. 31, 1910. Comprises a sleeve provided with a radially extended longitudinal chamber, complemental cup-shaped shells mounted on the sleeve and forming a reservoir, one of the shells being provided with a flange, a second flange secured to the other shell, a tread secured between the flanges, and means for conducting oil from the reservoir to the chamber.

1,002,141. DETERMINING POSITION OF VESSELS. Reginald A. Fessenden, Washington, D. C., assignor to National Electric Signaling Co., Pittsburg, Pa. Original application filed Dec. 4, 1904. Renewed Mar 18, 1907. Divided and this application filed Aug. 21, 1905. A set of stations have means to send out messages of predetermined intensity. Vessels receiving such signals have means for measuring the relative intensity of the impulses.

1,002,181. SIGNALING SYSTEM. Harry O. Rugh, Sandwich, Ill., assignor to Sandwich Electric Co., Sandwich, Ill. Original application filed June 26, 1908. Divided and this application filed Mar. 27, 1909. Substations are called from the central station by means of selector mechanism, polarized relays, etc.

1,002,191. DRIVING MECHANISM. Vincent G. Apple, Dayton, O. Original application filed May 27, 1908. Divided and this application filed Apr. 12, 1909. Comprises a shaft mounted for sliding and rotary movement; an abutment fixed longitudinally with respect to the shaft, and a governor carried by the shaft, comprising bearing plates, one on each side of the shaft, eccentrically mounted rollers therebetween, movable under the influence of centrifugal force to act upon the abutment to move the shaft axially, and yieldingly means acting upon the end of the shaft opposing such movement of the shaft.

PATENTS THAT HAVE EXPIRED.

Following is a list of the electrical patents (issued by the United States Patent Office) that expired September 4, 1911:

525,332. ELECTRIC SWITCH. George F. Card, Covington, Ky.

525,336. CONTROLLING DEVICE FOR ELECTRIC RAILWAY CARS. William H. Conrad, Lebanon, Pa.

525,353. DYNAMO-ELECTRIC MACHINE. James F. McElroy, Albany, N. Y.

525,354. ELECTRICAL CURRENT DIRECTOR, James F. McElroy, Albany, N. Y.

525,369. ELECTRIC LIGHTING SYSTEM AND APPARATUS. Elihu Thomson, Lynn, Mass.

525,394. CONTROLLER FOR ELECTRIC OR OTHER MOTORS. Elmer A. Sperry, Cleveland, Ohio.

525,395. SYSTEM AND APPARATUS FOR CONTROL OF ELECTRIC MACHINES. Elmer A. Sperry, Cleveland, Ohio.

525,400. ELECTRIC LOCK. Frederick Apitz, Lockport, Ill.

525,437. ELECTRIC CIGAR LIGHTER. Albert C. Albertsen, Chicago, Ill.

525,445 and 525,446. SYSTEM OF ELECTRICAL DISTRIBUTION. Thomas C. Coykendall, Rondout, N. Y.

525,447. ALTERNATING-CURRENT MOTORS. Olof Dahl, Paterson, N. J.

525,480. ELECTRIC-RAILWAY SYSTEM. Francis B. Badt, Chicago, Ill.

525,491. ELECTRIC BATTERY. Luis Drescher, New York, N. Y.

525,539. CONDUIT ELECTRIC-RAILWAY SYSTEM. Oscar A. Enholm, New York, N. Y.

525,563. ELECTRICAL CUT-OUT. August Rockoff, New York, N. Y.

525,564. HANDPIECE FOR PORTABLE ELECTRIC LAMPS. August Rockoff, New York, N. Y.

525,653. ROSETTE FOR ELECTRIC-LIGHT WIRES. Charles N. Hammond, Boston, Mass.

525,670. UNDERGROUND CONDUIT. Alexander Segade and Dennis J. O. Regan, Detroit, Mich.